1.6.3 Procedures

1.6.4 Guidelines

1.6.5 Other Documents

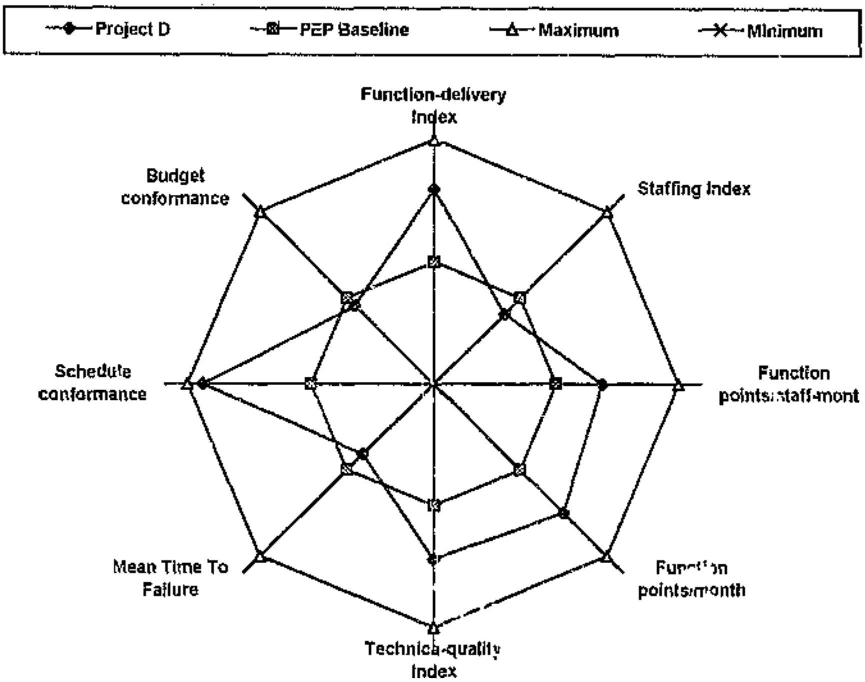
a. FPA Documents

b. SPICE Documents

1.7 Assumptions

1.8 Requirements Traceability

2 PEP Footprint



3 Details

	Actual	Baseline	Difference / Multiple
Fdi (AB)	20.9	14	6.9
SI (AB)	9.3	7.1	2.2
fp/sm	38	13	2.9
fp/mo	78	20	3.8
Time Slippage %	-53%	25%	-2.1
Effort overrun %	25%	20%	1.3
Tql	12.1	10.0	2.1
MTTF	11.0	14.1	0.8

MLA QMS

Work Breakdown Structure For Project C

Management Product

Version 1.00

Document Status: Approved

Table of Contents

Change History

Configuration Control

Project:	MLA QMS
Title:	Work Breakdown Structure for Project C
Doc. Reference:	C:\MY DOCUMENTS\1996_24\TP\MLA324.100
Created by:	Melanie Lang
Creation Date:	10 August 1998

Document History

Version	Datr	Status	Who	Saved as:
0.01	97\05\05	Draft	Melanie Lang	MLA324.001
0.02	97\05\16	Draft	Melanie Lang	MLA324.002
1.00	98\08\10	Approved	Melanie Lang	MLA324.100

Revision History

Version	Date	Charges
0.01	97\05\05	New document created from MLA002.102
0.02	97\05\16	Additions of actual schedule.
0.02	98\06\28	Additions of actual schedule and outputs.
1.00	98\08\10	Document approved and checked

Management Authorisation

Version	Date	Status	Management Board Minute Reference
1.00	98\08\10	Approved	MLA 2031 section 2.9

Change Forecast

1 Scope

1.1 Introduction

This document goes into the detail in section 10 of MLA323.

1.2 Purpose

To manage the subproject of a SPICE assessment on a process instance which has been part of the previous PEP project cycle.

1.3 Applicability

1.4 Definitions

1.5 Audience

The audience for this document comprise the various stakeholders of the SEAL, including:

- The student undertaking this M.Sc. project.
- Interested members of Eskom IT, including my team leader, the IT Application Systems Quality Team and the IT Application Systems Manager.
- The supervisor of this M.Sc. project.
- Members of the SEAL Management Board.
- Head of Department of Electrical Engineering.
- Individuals who perform internal and external audits on projects undertaken within the SEAL Quality Management System.
- All involved in the assessed project.

1.6 Applicable Documents

1.6.1 Specifications

1.6.2 Standards

a. SEAL QMS Document Creation Template, QS 002, Revision 0.02, 3 October 1994

b. SEAL QMS Document Layout, Presentation and Typesetting Guide, QS 003, Revision 1.00, 3 October 1994

1.6.3 Procedures

1.6.4 Guidelines

1.6.5 Other Documents

a. FPA Documents

b. SPICE Documents

1.7 Assumptions

1.8 Requirements Traceability

2 Proposed Project approach

The high level proposed project approach from the feasibility study document has been expanded below:

2.1 Key for table below:

Under the actual person-hours column, numbers which appear in brackets indicate tasks which have already been integrated with another, indicated firstly by the heading number, and then the number of the row in square brackets.

All dates are for 1997, unless otherwise recorded.

Where estimates differ from actuals, the actuals are recorded in [] after the estimate.

2.2 Phase 1: Preparation and planning

TASK		OWNER-SHIP	STATUS	REFERENCE	START DATE	END DATE	ACTUAL PERSON-HOURS
1.	Assessment Initiation	ML	Complete		08/05 [12/05]	08/05 [12/05]	
1.1.	Initiate assessment - secure project and agreement or contract	ML	Complete				
1.2.	Establish processes and area to be assessed, as well as work products	ML	Complete				
2.	Define and document process	ML	Complete		05/05	28/05	
2.1.	Preparing the Assessment Input	ML	Complete	MLA 323			
2.2.	Develop Feasibility Study	ML	Complete	MLA 323			
2.3.	Develop Work Breakdown	ML	Complete	MLA 324			
2.4.	Develop Quality Plan	ML	Complete	MLA 325			
3.	Conduct training	ML	Complete				
3.1.	Assessor training in use of SPICE, instrument and tool	ML	Complete		07/02/1996	08/02	
3.2.	Prepare training material	ML	None	-	-	-	
3.3.	Briefing the sponsor and/or OU staff about the methodology to be used	ML	Complete		08/05	08/05	(2.2[1])
4.	Preparation	ML	Complete				
4.1.	Schedule assessment interviews	ML	Complete		09/05	16/05	
4.2.	Review input with assessment sponsor, obtain approval and validate assessor qualifications.	ML	Complete		08/05	08/05	
4.3.	Informal site visits to get the 'feel' for the processes and	ML	Complete		1996	1996	?

TASK		OWNER-SHIP	STATUS	REFERENCE	START DATE	END DATE	ACTUAL PERSON-HOURS
	products - this was part of the function point count.						
4.4.	Select compatible model, method and instrument	ML	Complete		05/05	05/05	(2.2[1])

2.3 Phase 2: Assessment and analysis

TASK			OWNER-SHIP	STATUS	REFERENCE	START DATE	END DATE	ACTUAL PERSON-HOURS
1.	Conduct assessment		ML	Complete	Sealoq.db	12/05	16/05 [24/06]	
	1.1.	Record a rating for each process attribute for each process instance	ML	Complete				
	1.2.	Collect objective evidence to substantiate the ratings, based on indicators, including:	ML	Complete				
		1.2.1. practices examined	ML	Complete				
		1.2.2. work products examined	ML	Complete				
		1.2.3. people interviewed	ML	Complete				
		1.2.4. rating justification	ML	Complete				
2.	Analyse Findings		ML	Complete	MLA 326	12/05	27/05	
	2.1.	Verify and validate the ratings and evidence and correct assessment accordingly	ML	Complete	MLA 326	12/05	16/05	
	2.2.	Manage risks and quality of ratings and evidence and correct plan accordingly	ML	Complete	MLA 326	2/05	16/05	
	2.3.	Record set of process attribute ratings as a process profile	ML	Complete	MLA 326	12/05	16/05	

TASK		OWNER-SHIP	STATUS	REFERENCE	START DATE	END DATE	ACTUAL PERSON-HOURS
2.4.	Record evidence to verify compliance with the requirements from:	ML	Complete	MLA 323	05/05	28/05	(2.2[2.1])
2.4.1.	reference model part 2 and exemplar model part 5	ML	Complete				
2.4.2.	conducting an assessment part 3, including defined indicators	ML	Complete				
2.4.3.	documented process	ML	Complete				
2.4.4.	assessor guidance and competence part 6	ML	Complete				
2.4.5.	choice of assessment instrument part 4.	ML	Complete				
2.5.	Negotiate modifications to the assessment input with the sponsor	ML	Complete	MLA 326	08/05	28/05	
2.6.	Review the assessment results with independent internal and correct assessment accordingly	ML	Complete		19/05	19/05	

2.4 Phase 3: Reporting and close-out

TASK		OWNER-SHIP	STATUS	REFERENCE	START DATE	END DATE	ACTUAL PERSON-HOURS
1.	Prepare assessment results	ML	Complete	MLA 328	20/05	21/05 [20/06/1998]	
1.1.	Document general findings, conclusion and recommendations	ML	Complete				
1.2.	Generate report	ML	Complete				
2.	Prepare assessment presentation	ML	Complete		22/05	26/05	

TASK		OWNER-SHIP	STATUS	REFERENCE	START DATE	END DATE	ACTUAL PERSON-HOURS
2.1.	Prepare presentation, including venue, attendees and barco	ML	Complete	MLA 329	06/05	13/05 [28/06/1998]	
2.2.	Present results to assessment participants	ML	Complete				
2.3.	Distribute assessment output for review	ML	Complete				
3.	Prepare assessment presentation to assessment owner and immediate stakeholders	ML			27/05	27/05	
3.1.	Prepare presentation, including venue, attendees and barco	ML	Complete	MLA 349	06/05	13/05 [28/06/1998]	18
3.2.	Present results to stakeholders	ML	Complete				
3.3.	Distribute assessment output to stakeholders	ML	Complete				
4.	Close out project	ML			28/05	28/05	
4.1.	Complete trials questionnaires with interviewees	ML	No longer required				
4.2.	Complete trials questionnaires with sponsor	ML	No longer required				
4.3.	Assessor to complete trials questionnaires	ML	No longer required				
4.4	Prepare lessons learned and presentation comments document	ML	Complete	MLA 329	06/05	13/05 [28/06/1998]	

MLA QMS

SPICE Profile For Project C

Management Product

Version 1.00

Document Status: Approved

Table of Contents

Change History

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Project:	MLA QMS
Title:	SPICE Profile for Project C
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0.01	98\05\05	Draft	Melanie Lang	MLA331.001
1.00	98\08\10	Approved	Melanie Lang	MLA331.100

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0.01	98\05\05	New document created from MLA002.102
0.01	98\05\12	Correction to copied picture
1.00	98\08\10	Document Approved and checked

Management Authorisation

Version	Date	Status	Management Board Minute Reference
1.00	98\08\10	Approved	MLA 2031 section 2.10

Change Forecast

1 Scope

1.1 Introduction

This document lists the details from SPICE profile for project C.

1.2 Purpose

1.3 Applicability

1.4 Definitions

1.5 Audience

The audience for this document comprise the various stakeholders of the SEAL, including:

- The student undertaking this M.Sc. project.
- Interested members of Eskom IT, including my team leader, the IT Application Systems Quality Team and the IT Application Systems Manager.
- The supervisor of this M.Sc. project.
- Members of the SEAL Management Board.
- Head of Department of Electrical Engineering.
- Individuals who perform internal and external audits on projects undertaken within the SEAL Quality Management System.
- All involved in the assessed project.

1.6 Applicable Documents

1.6.1 Specifications

1.6.2 Standards

a. SEAL QMS Document Creation Template, QS 002, Revision 0.02, 3 October 1994

b. SEAL QMS Document Layout, Presentation and Typesetting Guide, QS 003, Revision 1.00, 3 October 1994

1.6.3 Procedures

1.6.4 Guidelines

1.6.5 Other Documents

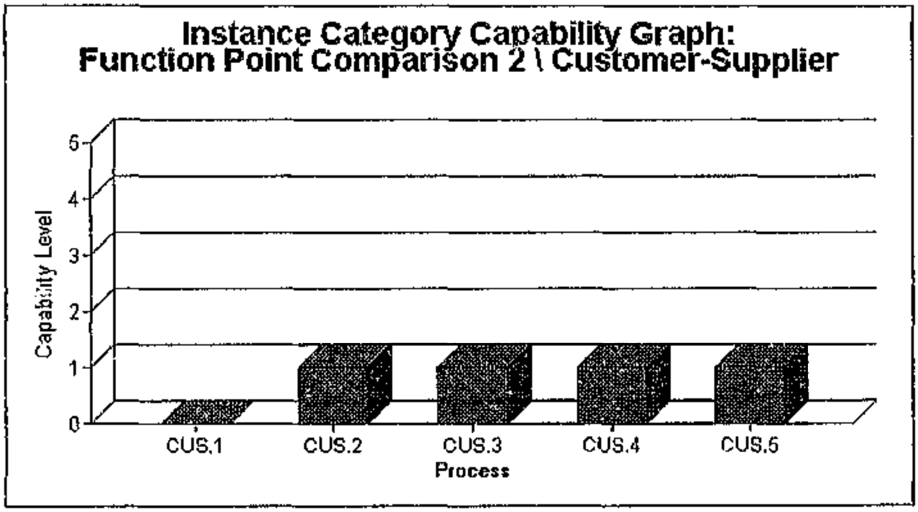
a. FPA Documents

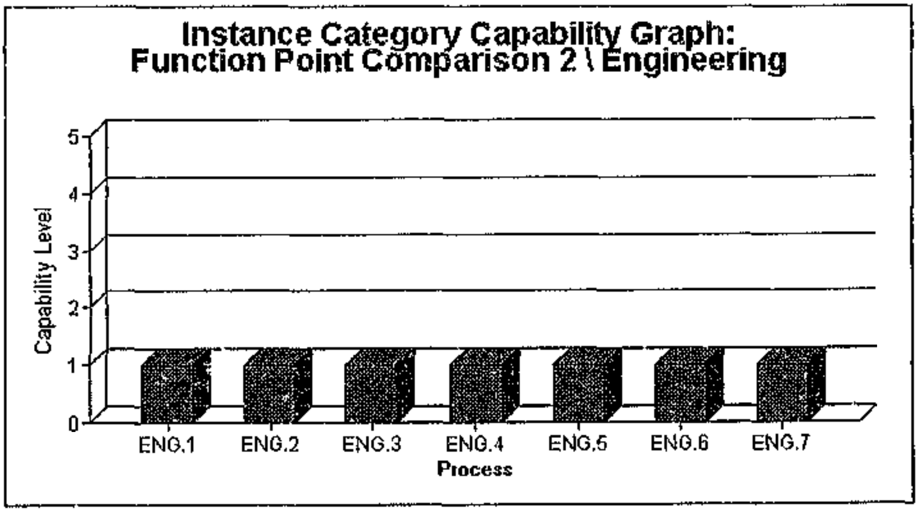
b. SPICE Documents

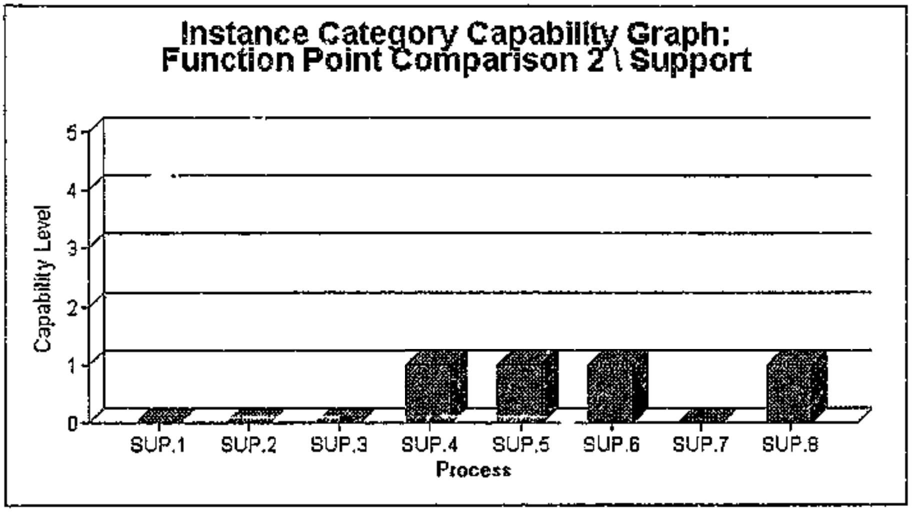
1.7 Assumptions

1.8 Requirements Traceability

2 SPICE Profile



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2
3
4
5
SUP.1
SUP.2
SUP.3
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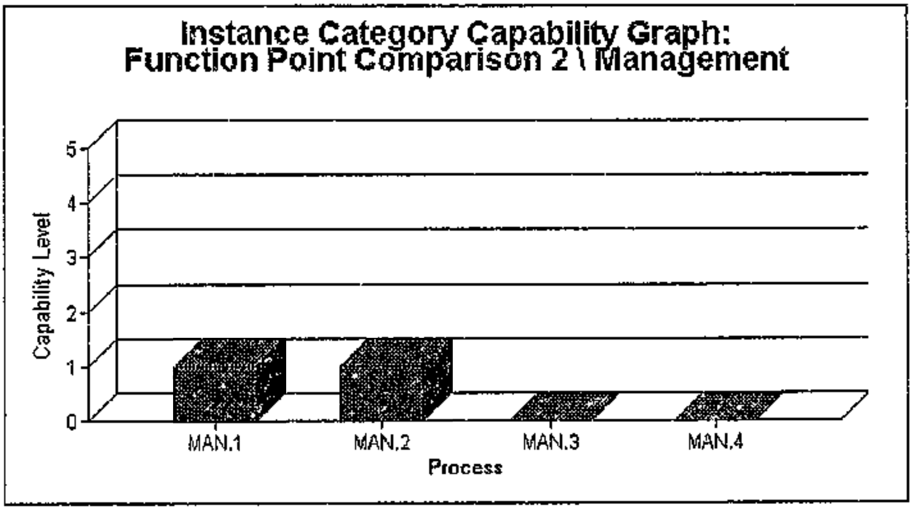
SUP.7
SUP.8
Process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Capability Level
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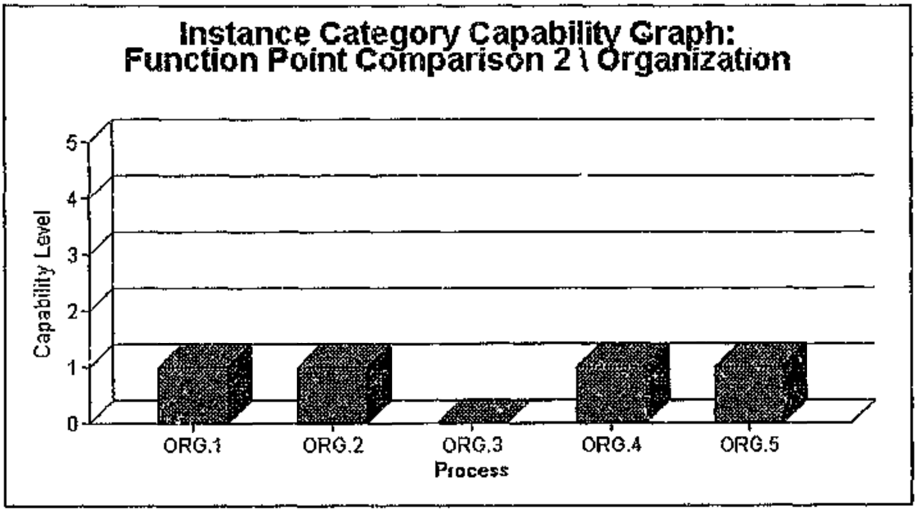
3
4
5
MAN.1
MAN.2
MAN.3
MAN.4
Process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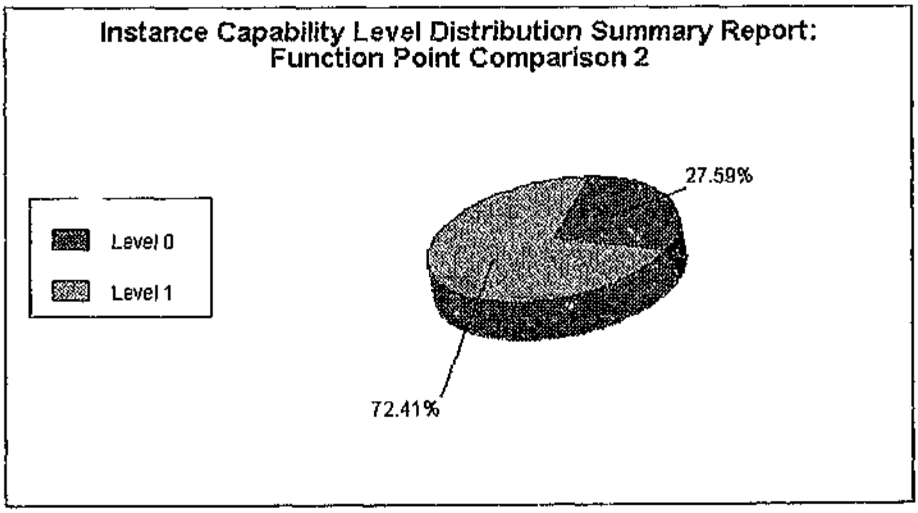
2
3
4
5
ORG.1
ORG.2
ORG.3
ORG.4
ORG.5
Process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Function Point Comparison 2
Level 0
Level 1
27.59%
72.41%

MLA QMS

SPICE Profile For Project D

Management Product

Version 1.00

Document Status: Approved

Table of Contents

Change History

Configuration Control

Project:	MLA QMS
Title:	SPICE Profile for Project D
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Creation Date:	10 August 1998

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0.01	98\05\05	Draft	Melanie Lang	MLA341.001
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Revision History

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0.01	98\05\05	New document created from MLA002.102
0.01	98\05\12	Correction to copied picture
1.00	98\08\10	Document Approved and checked

Management Authorisation

Version	Date	Status	Management Board Minute Reference
1.00	98\08\10	Approved	MLA 2031 section 2.9

Change Forecast

1 Scope

1.1 Introduction

This document lists the details from SPICE profile for project D.

1.2 Purpose

1.3 Applicability

1.4 Definitions

1.5 Audience

The audience for this document comprise the various stakeholders of the SEAL, including:

- The student undertaking this M.Sc. project.
- Interested members of Eskom IT, including my team leader, the IT Application Systems Quality Team and the IT Application Systems Manager.
- The supervisor of this M.Sc. project.
- Members of the SEAL Management Board.
- Head of Department of Electrical Engineering.
- Individuals who perform internal and external audits on projects undertaken within the SEAL Quality Management System.
- All involved in the assessed project.

1.6 Applicable Documents

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a. SEAL QMS Document Creation Template, QS 002, Revision 0.02, 3 October 1994

b. SEAL QMS Document Layout, Presentation and Typesetting Guide, QS 003, Revision 1.00, 3 October 1994

1.6.3 Procedures

1.6.4 Guidelines

1.6.5 Other Documents

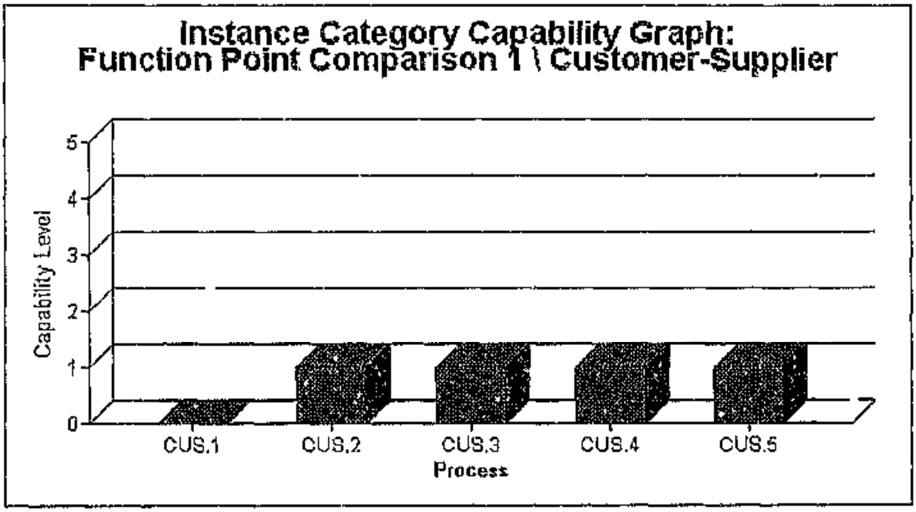
a. FPA Documents

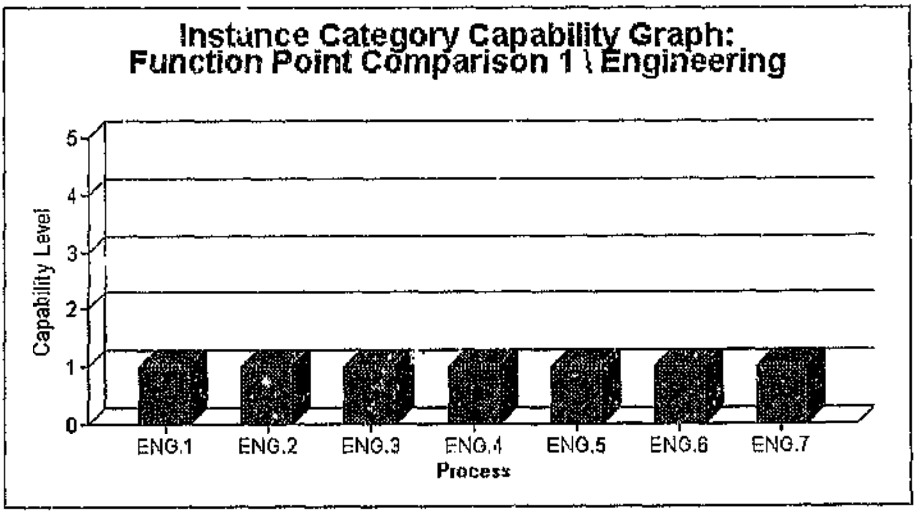
b. SPICE Documents

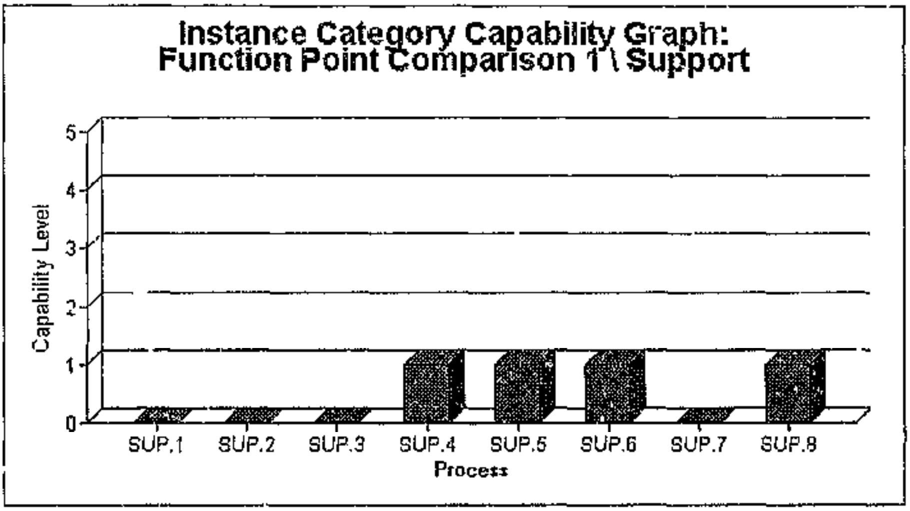
1.7 Assumptions

1.8 Requirements Traceability

2 SPICE Profile



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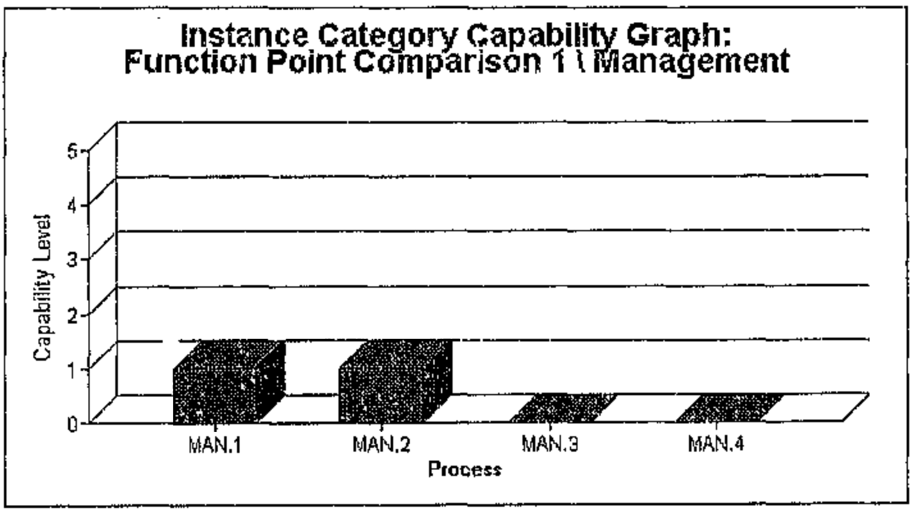
1
2
3
4
5
SUP.1
SUP.2
SUP.3
SUP.4
SUP.5
SUP.6
SUP.7
SUP.8
Process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Capability Level
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3
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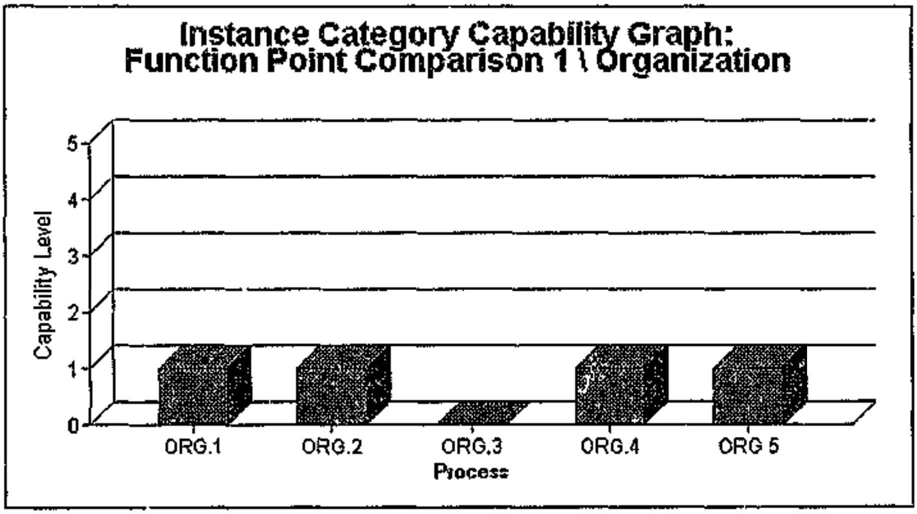
5
MAN.1
MAN.2
MAN.3
MAN.4
Process


Instance Category Capability Graph:
Function Point Comparison 1 \ Organization
Capability Level
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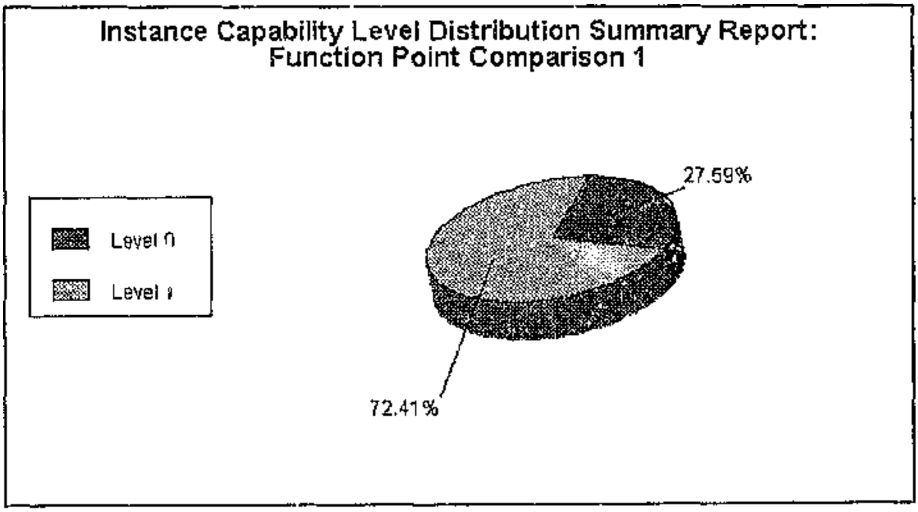
1
2
3
4
5
ORG.1
ORG.2
ORG.3
ORG.4
ORG 5
Process


Instance Capability Level Distribution Summary Report:
Function Point Comparison 1
Level 0
Level 1
27.59%
72.41%

SPICE Assessment Feedback for Projects C and D

MT Lang

Eskom IT Application Systems Quality Team

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Melanie.Lang@eskom.co.za.

1 Introduction

The projects were new 2-month development projects used to develop a system in support of group business processes by the in-house IT department consisting of a project team of 5. The system was developed as part of an existing system, using predominantly fourth generation languages. Rapid Application Development methodology was used.

The SPICE assessment was performed as this project met the requirements for the assessor's MLA Masters research project i.e. it was assessed in the CSC PEP Programme Cycle 2, and therefore had both function point counts and a PEP footprint available, as well as being used by a core Eskom business function and hau no major problems regarding resource availability for interviews. A point of significance is that only one of the projects was to be assessed, but the interviewees who were involved on both asked for both to be assessed. There is only one process which differs in the assessment, which is why the report is presented together.

In function point and lines of code(LOC) terms they were small projects.

The technical environment was Client/Server and the target use of the product was as an information system. A moderate level of code reuse was achieved, but mainly as a result of the programmer's and programme team's software processes, rather than out of any significant organizational unit(OU) processes.

This document provides a summary of SPICE, the assessment methodology, the actual assessment, results obtained from the assessment and proposed enhancements to the existing processes.

2 Abbreviations

The following abbreviations are used throughout this document:

ATACC:	Advanced Test and Change Control
CASE:	Computer Aided Software Engineering
EDM:	Eskom Development Methodology
ITD:	Information Technology Department
MPO:	Macro Project Office
OU:	Organizational Unit
PEP:	CSC Performance Enhancement Programme
SPICE:	Software Process Improvement and Capability Evaluation

3 Software Process Improvement and Capability Determination

ISO/IEC 15504, also known as Software Process Improvement and Capability Determination or by the acronym SPICE is an international standard developed by ISO/IEC JTC1/SC7 WG10 to provide a structured approach for the assessment of software processes.

3.1 The SPICE Model

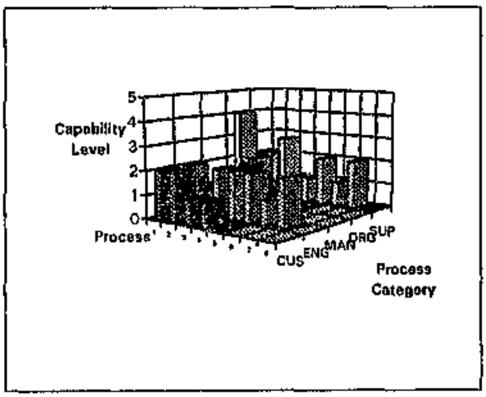
The model adopted by ISO/IEC 15504 is shown in Figure 1. Fundamental to the model is the concept of a process, which is described as *a set of interrelated activities, which transform inputs into outputs.*

Processes are examined using the mechanism of process assessment, defined as *a disciplined evaluation of an organisation's software processes.* The output of the assessment exercise is a profile, which can be used variously for process improvement (*Action taken to change an organisation's processes so that they meet the organisation's business needs and achieve its business goals more effectively*) and/or for determination of process capability - *a systematic assessment and analysis of selected software processes within an organisation against a target capability, carried out with the aim of identifying the strengths, weaknesses and risks associated with deploying the processes to meet a particular specified requirement.*

The two key components of the standard are a process model and guidance on conducting assessments.

The process model is made up of a framework of attributes in two dimensions: The Process dimension contains process categories, processes and base practices, and the Capability dimension contains capability levels, process attributes and management practices. Input and output work products are used as indicators of level of achievement of base and management practice.

Figure 2: The Dimensions of the SPICE Model

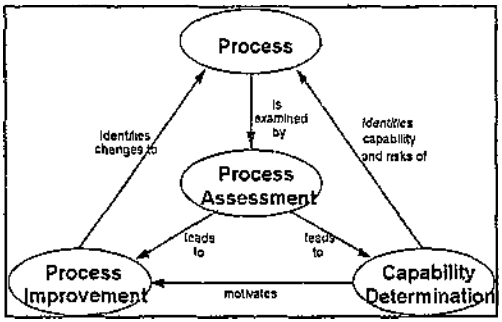


3.2 The SPICE Process Categories

Processes are grouped into general areas of activity called process categories:

1. Customer-Supplier (CUS)
2. Engineering (ENG)
3. Support (SUP)
4. Management (MAN)
5. Organization (ORG)

Figure 1: The Assessment Process



The processes in Figure 2 are enumerated for illustrative purposes, but they are not the same across all the process categories.

3.3 The SPICE Capability Levels

A capability level is *a set of process and management attribute(s) that work together to provide a major enhancement in the capability of a Supplier to perform a process.*

Each level provides a major enhancement of capability in the performance of a process. The levels constitute a rational way of progressing through improvement of the capability of any process.

There are six capability levels in the reference model.

As you progress up the capability maturity scale, you transform from not performing the process (level 0) to solely performing the process (level 1) to managing it at a team-based level (level 2) to using a defined organisation-wide process (level 3) to measuring it, and using it for effective prediction and process control (level 4) and then finally to optimising it (level 5).

The capability level of each process is independently assessed, by an assessor making a judgement supported by documented objective evidence. This may be based on practice attributes (by interviewing process practitioners and managers) or work product characteristics (by examining documents, plans etc.) provided by the SPICE embedded model. This leads to a collection of profiles which represent the assessment output, as seen in Figure 2.

A first assessment can form part of a baseline and then using the Guidelines for Process Improvement, improvements can be prioritised and implemented in accordance with organisational goals.

SPICE is a relatively new standard and is still undergoing development and phase 2 trials.

4 SPICE Assessment Methodology

This section details information additional to the standard SPICE Methodology as represented by the SEAL Of Quality v0.82 tool. Both the instrument and the methodology are SPICE compatible.

4.1 Assessment Input

The following people were involved in the assessment:

1. Erich Roberts was the sponsor and owner. A sponsor internal to the OU.
2. Melanie Lang was the qualified assessor responsible for the assessment.
3. Available process and project resources were the interviewees.
4. Christine Griesel was the internal auditor.
5. Prof. Walker was the external auditor

Refer to the Assessment Quality Plan (MLA325) for further detail on their responsibilities.

The purpose of the assessment was to provide a profile for comparison against the function point count and PEP footprint, providing additional insight into processes in other words a process assessment rather than for capability determination.

The assessment approach was self (performed by a member of the organisational unit), discrete (a 'snapshot at a point in time) and team-based (no automated tool was used, but a group was involved).

The assessment type was full (covering all processes), basic (without adding additional processes to the SPICE set) and initial (no previous assessment had taken place.

The scope of the assessment was all the processes, excluding Acquire Software and Manage Subcontractors, up to capability level 3 (Established Process) where applicable within Eskom IT Application Systems (about 200 people). Reasons for limiting this scope is that as a result of this being an assessment with an internal sponsor, the sponsor would only have control of those areas he managed and very few processes were expected to be at level 2 and even less at level 3.

Main constraints included:

- the availability of key resource and maximum amount of time to be used for the assessment. This was restricted to +- 1 hour for 6 days for the main interviewee;
- confidentiality agreements protected the identity of an interviewee outside the SPICE Assessment Team.

4.2 Assessment Approach

The assessment schedule involved Preparation and planning (of the assessment input and project and quality plans); Assessment and Analysis (with the identified resources and auditing with identified experts); and Close-Out and Reporting (Presentation to all involved).

4.3 Assessment Assumptions

The following assumptions were made during the assessment:

1. The assessment was conducted as far as possible with the project leader, and the assessment ratings were validated by reviewing the available documentation and cross-checking certain practices with other resources.
2. Most of the Organisation process category focussed on a much higher level, and was covered by the upper managerial roles, rather than the junior ones.
3. The main focus of the assessment was the Engineering and Customer-Supplier categories, but with the additional time, it was decided to complete the entire profile.
4. As this was a discrete assessment, it was essentially a snapshot of the processes at a point in time after the function point count had been done, and which was covered by the information in the PEP data capture forms. This meant that processes which may have been used later on in the year, were not assessed.
5. Due to the informal nature of the project, base practices were examined mainly on the basis of trust, rather than expected documented evidence, however, where documents were available, they were informally examined, although not rated, and listed in the Assessment Working Document (MLA326).
6. Main project members were available for interviews, but rather than them being 100% available for a week, the assessor had to be available to accommodate them. As a result of the time and this resource constraint, only the project

team leader and team member, group systems application manager, MPO project leader and applications manager were interviewed, and problems arose where areas were covered strictly by other project roles, although the project team leader's view was taken as objectively as possible. It was thus assumed that the project team leader was aware of most of the procedures followed, and problems encountered during the project, and could provide the most accurate view of the processes.

4.4 Assessment Risks

The following risks were considered throughout the assessment:

Table 1: Assessment risks and planned approaches

Risk	Management
The assessment may cross boundaries into areas which are not covered by the scope i.e. IT Application Systems.	Where possible, these processes were omitted from the assessment, as they were processes which were not under the control of the sponsor, and no changes to them could have been made. This meant that the next level of the assessment e.g. for the base practices, the process ratings would be adjusted to exclude that practice aggregation.
The size of the group of project resources, who each work on several areas, may cause problems in terms of coverage of the processes and capability levels.	The major source of information for doing the assessment was the project team leader, supported by the documents in the project folders.
The assessment team made use of the existing documentation that has been created to confirm the assessment rating. There was insufficient time to review every document that has been created.	A combination of interviews and investigation of the documents were used to do the assessment. It will be taken on trust that what has been stated and submitted by the assessment participants is true and correct.

5 SPICE Assessment Findings and Analysis

This section presents the profiles of each process category and summarises findings. For detailed evidence and ratings, consult the Assessment Working Document (MLA326).

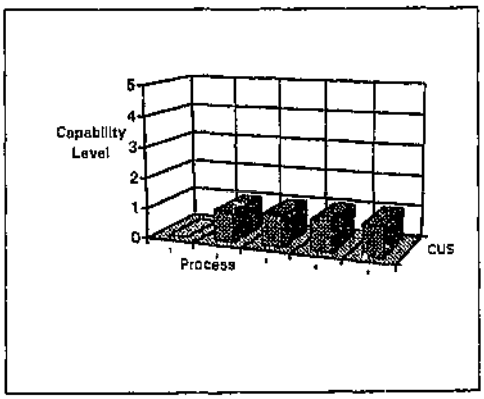
This section is in the following format:

- For each process category,
    - Description
    - Graph of process category
    - Summary of supporting evidence and findings
- Summary of findings
    - Summary graph
    - Summary of assessment findings

5.1 Customer-Supplier Process Category

These are *processes that directly impact the customer, support development and transition of the product to the customer, and provide for its correct operation and use.* They include: (1) Acquire software, (2) Manage customer needs, (3) Supply software, (4) Operate software and (5) Provide customer service.

Figure 3: Customer-Supplier Process Category



1. Acquire Software was excluded from the assessment, as it was assumed that the customer had defined the need, business case and then approached IT with high level requirements, as one of the possible suppliers to produce a suitable contract.

2. The customer provided the pool rules document which formed the system requirements. They were also involved in development on a daily basis, involved in extensive reviews and communicated with the IT applications manager for group. This was still too informal to make the Manage Customer Needs process of a higher capability level.

3. As the project was based on time and materials, formal contract was negotiated and costs were never discussed. Feedback i.t.o. progress and risks were communicated regularly. Upgrades to the system were emailed to most sites to replace old version and for remote sites, on-site installation was performed. An 'upgrade' facility exists on the current system.

4. Operational risks centred around client/server issues, but no plans were developed to manage these. Dry runs by the user were used for operational testing. This software was a part of the programme's environment and no problems were experienced. User requests were emailed to the team leader and tracked. The server capacity and performance was actively monitored.

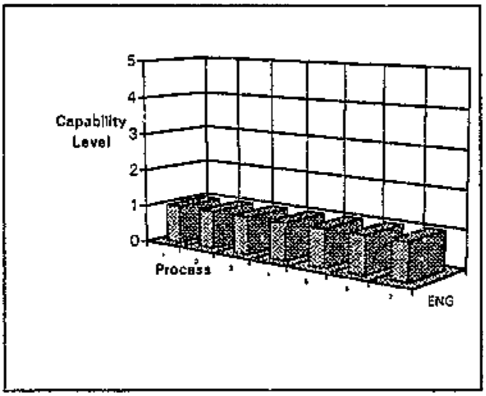
5. Training was not necessary due to the close user involvement, but they conducted their own additional training to others, support was managed through Customer Care (Eskom IT's one stop customer service) and monitoring performance was performed on databases. Customer satisfaction was established and communicated, with the team receiving several awards for their efforts. Comparisons were done internationally that the system was highly automated, but did not have the bells and whistles, giving unfavourable feedback to the customers who had requested the system be developed.

Generally, there was a fairly good relationship between customer and team facilitating this process, but a different team and/or customer may not have resulted in the same assessment. Most base practices are performed. The strengths of this process category is mainly as a result of the customer's relationship with the team The weaknesses of this process category was that the minimal level of configuration management that was used would make it difficult to repeat.

5.2 Engineering Process Category

These are *processes that directly specify, implement, or maintain a system and product and its user documentation.* They include: (1) Develop system requirements and design; (2) Develop software requirements; (3) Develop software design; (4) Implement software design; (5) Integrate and test software; (6) Integrate and test system; and (7) Maintain system and software.

Figure 4: Engineering Process Category



1. The programme system architecture defined the basic requirements. Programme version and change control influenced the release strategy. No formal communication mechanisms existed, as there was a close relationship with the customer. For project D, the old system was replaced with 30% additional requirements and an additional component to be integrated. For project C, the customer provided a document describing the process they wanted implemented

2. Software requirements such as environment, tools and operating environment were derived from programme standards. Only a single release was developed and one customer formed the single point of contact. A prototype screen was developed to evaluate project D requirements, while an algorithm was provided to evaluate project C requirements

3. SQLWindows environment and programme architecture was in place. An issues document tracked the detailed design. Complete traceability between requirements and design could not be established.

4. Code units with comments were implemented. No other implementation documentation was developed. Individuals were responsible for component testing and programme test procedures were used. Extensive verification was performed through dry runs in the test cycles.

5. Software and system testing were treated as the same. Thorough re-testing was the regression test strategy. The test conditions and time and order of execution, which formed the process was provided

by the user, as well as a test schedule. Test were not formally documented, but developers who were experienced in the business area understood the needs. User assisted with testing. Live data was cross checked with manual calculations and the old system outputs. Resulting problems were informally noted.

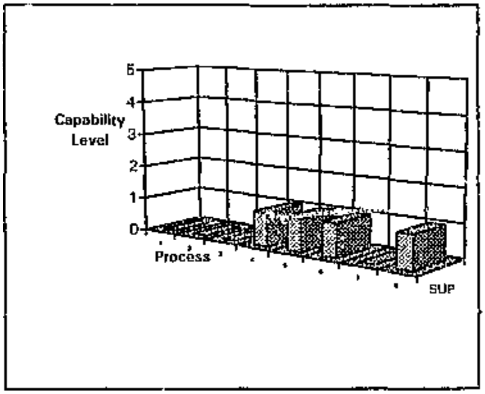
f The business process was continually improved, resulting in the supporting system requiring maintenance for several months and a database enhancement forced some re-design and re-construction. 'Blue Book' (programme's database standards) was updated with the latest database information. These changes did not require retraining or retiring of the old system.

The Engineering process category is performed placing all of the processes on level 1. Processes were dependent on the team which has been dedicated to servicing group, and in particular this team which was dedicated to project requirements. Standard process consisted of Eskom Development Methodology tailored for Rapid Application Development. The strengths of this process category are that most base practices performed; process performance were based on team's previous experience. The weaknesses of this process category are that only some documents are under configuration management; the minimum quality of some of the work products are not defined and informally controlled; in other words, there are some standard formats, some verification and validation is performed such as reviews and audits; and version control. The weaknesses arise mostly from the lack of work product management practices as described by the Capability level 2 of the SPICE model.

5.3 Support Process Category

These are *processes that may be employed by any of the other processes (including other supporting processes) at various points in the product development life cycle.* They include: (1) Develop documentation; (2) Perform configuration management; (3) Perform quality assurance; (4) Perform work product verification; (5) Perform work product validation; (6) Perform joint reviews; (7) Perform audits; and (8) Perform problem resolution.

Figure 5: Support Process Category



1. No formal documentation requirements were defined, but programme required the 'Blue Book' to be kept up to date. Documents (those which did exist electronically) were stored on the server and distributed to those who needed access. Other than the 'Blue Book', no other documents were maintained or checked.

2. PVCS was the tool used for configuration management on software code, but nothing existed for documentation. Only a single version of project D was released. An informal configuration management library existed on the network server and CASE database. Only 2 people had write access for documents and source code. Change control of most items were informal, and only recorded during maintenance.

3. Quality assurance was project team's responsibility. The only criteria checked was functionality, performance became an issue later. Team leaders ensured quality of work products and process. QA mainly consisted of testing and walkthroughs. The Christmas time period during which this project was run meant that no resources outside the team were available for peer reviews.

4. Traceability from original requirements was not fully defined. The system was the only work product verified through dry runs (walkthroughs) and testing. Requirements changed daily and reviews were performed by the customer.

5. These reviews also formed the validation. All users were involved in dry runs and worked according to the defined test schedule. Anomalies were communicated by the user phoning the team leader, who informed the developer of the ch... to be implemented, who sent the change application to the user.

6. Joint reviews consisted mainly of the dry runs where all required support personnel were available. Management and technical reviews were constantly done and software process assessments were not done.

7. No project audits were conducted. 2 external information audits were done on programme in it's entirety.

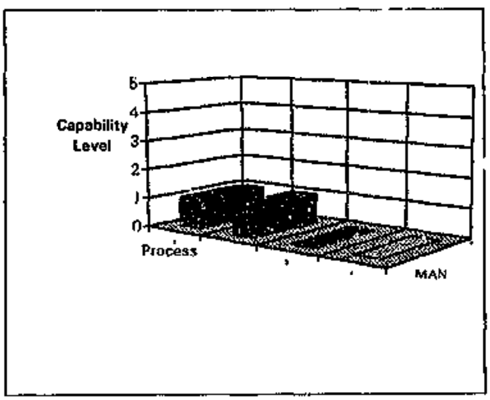
8. Pr lem resolution took the form of the customer di..dy contacting the developer or a standby group after-hours. Problem details, prioritisation, resolution and tracking was done using ARS (Eskom IT's Production problem management system) and SLA's (Service Level Agreement between customer and IT). Defect correction and distribution was performed immediately on environmental problems, otherwise according to priority. No defect analysis was performed.

This process category has much improvement potential with many of the base practices not fully performed. The strengths of this area consist mostly of the fact that a customer was fully involved in all verification, validation and joint reviews. Better attention to documentation and configuration management would improve processes. Other quality assurance techniques should be investigated.

5.4 Management Process Category

These are *processes that contain practices of a generic nature which may be used by anyone who manages any sort of project.* They include: (1) Manage the project; (2) Manage quality; (3) Manage risks; and (4) Manage subcontractors.

Figure 6: Management Process Category



1. Scope of work, project estimates, work breakdown structure. project schedule and infrastructure requirements were performed, using MS Project project plans. Project was time-boxed. Customer defined the development strategy and allocation of responsibilities, often making the project difficult to control. Rapid application development life cycle was used. A weekly project meeting kept the customer informed of the project tracking. Project performance was evaluated through walkthroughs and testing.

2. The only quality criteria was the functionality and schedule and measured through error tracking and peer testing. Test records were kept. Quality was not formally managed.

3. Risk management was performed at the programme level as part of the project strategy. At the project level, they were only managed after they became issues.

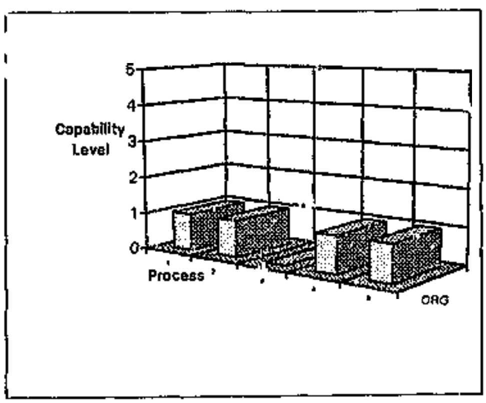
4. No subcontractors were managed.

Difficulties arose as a result of the fact that management crossed boundaries outside the organisational unit. This made it difficult to control, and although this ensured that specific quality criteria were met, it was likely that IT specific criteria had to be forfeited to meet these.

5.5 Organization Process Category

These are *processes that establish the business goals of the organisation and develop process, product, and resource assets which, when used by the projects in the organisation, will help the organisation achieve its business goals.* They include: (1) Engineer the business; (2) Define the process; (3) Improve the process; (4) Provide skilled human resources; and (5) Provide software engineering infrastructure.

Figure 7: Organization Process Category



1. A strategic vision was established for the organisational unit, but not many people seemed to

be aware of it, indicating a problem with deployment. The appointment of a quality advisor and subscription to an international benchmarking programme was considered to be the starting point of establishing a quality culture. Programme had an integrated team. Formal incentives for the project were provided. Recognition / rewards are based on end product rather than process outputs (End product is usually considered to be a working system - process outputs are intermediate deliverables, which would indicate a well-documented system which is easily maintainable and possibly contributes to future projects). For those who chose to participate, there was a Personal Development Plan (PDP) for career development.

2. This project was not used specifically to either define or improve existing OU processes, although it (among others) could have been one of the contributing factors to future process definition. Processes which were being defined at this time was Advanced Test and Change Control (ATACC) for Eskom's standard test and change control process and Macro Project Office (MPO) for Eskom's standard project management process. The AMI team tried to introduce processes through weekly information meetings. The base practices were mostly partially to largely performed with no policy for it's use and no performance expectations. Process measures took the form of PEP Baselining and function point counting and numbers of errors per cycle, PVCS usage and rate of success of issues for programme subprojects. Human resources for supporting process definition were informally defined and provided through the AMI team, MPO resources and the Quality Advisor.

3. As the processes for MPO and ATACC were currently undergoing definition in the timeframe assessed, these processes would improve the current practices. However, for the Eskom Development Methodology (EDM) which had been defined prior to this timeframe, improving the process would mean improving the EDM itself. An object orientation pilot project was run to establish viability. There were no formal plans, resourcing, standards or process infrastructure for future process improvements i.e. it appears to be ad hoc, and not a direct result of organisational goals.

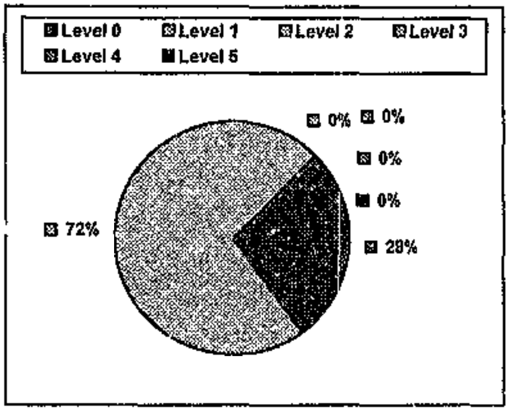
4. PDP's and business plans were used to identify human resource needs. These were used by the training department to acquire training courses. All programme resources were required to attend training in SQLWindows and Oracle. Project teams are defined and available resources with the necessary skills are selected, otherwise the recruitment process is started. The Personal Performance Contract, Job Output Models and team Performance Appraisals are used to evaluate staff performance and feedback then given. Good personnel records are kept, no formal training records are kept and skills information was previously kept in the EDCO system but is now outdated. All programme team members have a common vision to support customer's business. Empowerment and team interactions are not formally defined.

5. Software engineering infrastructure are limited to technology specific issues and physical infrastructure, as well as several team standards. A reuse library in the form of the use of SQLWindows component libraries is partially in place, however not organization wide or as a formal part of the life cycle.

This process category was sometimes difficult to assess on a project level, and was taken on a much broader view. For the Provide Skilled Human Resources process, SPICE suggests that training and skilling is the responsibility of managers, however the OU took a human-centred approach, where each individual is responsible for him/herself and empowered to make their own decisions. This may also be the reason that it performed better than the others. This may be the reason for unsuccessful deployment of other processes. The fact that people are empowered, means they manage and control their own decisions and their subordinates, so instead of having to obtain commitment from 1 manager, the process deployment teams have to obtain commitment from 200 'managers'. Although processes are defined, there is no arrangements for future improvements. Infrastructure by means of organisation-wide standards and resource libraries (of all configuration items) did not exist, but was provided for the physical and language software engineering environments. As a result of the high team coordination, cooperation and transparency and the move towards resource libraries, many of the processes are at level 1.

5.6 Summary

Figure 8: Derived SPICE Profile



1. **Capability:** This project is mainly at capability level 1, performing a large number of the base practices and many of the activities managed by the various levels of leadership. As a result of processes not existing, or the one's being used on the project not being documented, the project would only be unrepeatable if resources within the same teams are used. Most of the teams making use of the processes will never achieve higher than level 2. The crux of level 1 are that processes are not dependent on individuals, i.e. if someone else in the team had to be given the same project, they would be able to achieve the same level, apart from several individualistic areas where they may be stronger or weaker. Level 3 is dependent on the fact that anyone in the department would be able to take on the project and not specifically the team involved. This of course would take into consideration management practice 2.1 that an individual with the required skills was chosen. However, the fact that the Engineering processes had the most highly skilled resources may indicate that individuals have to acquire skills in the other SE processes (eg. manage quality, develop documentation). This would also mean that it would not make a difference if anyone else in the OU had been managing eg. quality instead, since they would have had as much skill as another person.

2. **Experienced Resources:** The projects assessed definitely had highly proficient and skilled resources who did not necessarily need processes to ensure best practices, but the lack of correct documentation would make it difficult in future for maintenance. The nature and experience of the team made them inadvertently follow basic software engineering practices, but nothing formalised, or documented, which would lead to a repeatable process. These software engineering practices were also more easily planned, tracked and managed than the support and management category practices.

3. **Service Provision:** Eskom projects appear to be highly pressurised, where customer requests are often satisfied without regard for what may be 'healthy' for the OU. OU members seem to be condemned to a service provider role (except in one-off projects). This situation is a hindrance to proper planning, tracking and management since unplanned for emergencies interfere with work which cannot be rescheduled. This forces project resources to work long hours, often with no additional reward. This could have an effect on employee (dis)satisfaction.

4. **Size Counts:** The fact that the systems are rather small has a positive impact, since they appear to be easier to plan and manage, although constraints remain severe.

5. **Process Owner:** A major problem is that there is no clear definition of who owns / is responsible for which part of most processes.

6. **Existing Procedures and Libraries:** The fact that there are a number of procedures and even resource libraries that have been defined was a pleasant surprise. Unfortunately, they are not widely enough available or in some cases, are rejected by process users as being too broad to be applicable. Standalone projects are usually thought to be fairly simple and not requiring processes, however existence of standard departmental processes, architecture and various libraries of resources would not only speed up development, but also assist in maintenance. Engineering process category standards are centralised in the 'Blue Book' (Programme's database standards).

7. **Feedback Loop:** For the existing standard processes, there is currently no mechanism in place for those who use it (and possibly tailor it) to provide feedback to the owners, so that they can be modified, or the tailoring can be noted as a possibility. Although the processes state that they should be re-looked at every half-year, this does not happen, as there is no responsibility assigned for this.

8. **Pilot Process Projects:** Different requirements of each site makes using a pilot project to test a process difficult. It is important to take the pilot site's problems into account in context with the influence and requirements of the rest of the OU.

Processes could be beta tested where responsible parties within all (development and maintenance) teams gather observations from within their programmes or their functional areas and communicate these to the process definition and improvement change control administrator. This would then be incorporated into each project's plan.

9. **Intangible System:** Prototyping is used as the excuse when requirements cannot be gathered for a system, but if a system is supposed to fulfil a business function regardless of the technology or the interface, this should be able to be gathered during analysis and design and during detail design, interface and other issues may be considered. This is a problem with both user and development teams, since the user is usually unable to visualise and developers are unable to explain a virtual system. It is important that "visionary" users and business analysts be involved at the requirements level and that "visionary" users, business and system analysts be involved at the detail design level. This will mean that a project can move through a waterfall model and not require as much rework as continual re-development will require.

10. **Maintenance of Work Products:** In general, projects are fairly well done and documented as far as allowed i.e. if a customer demands a delivery date, the resources do as much as possible by that date, but documentation is often not considered to be of as high a priority, particularly when a project is timeboxed. There is a tendency after moving to the next phase to ignore maintenance of output work products or deliverables from previous phases (e.g. changes noted in minutes, must be recorded as change requests, and updated in code, test data, design, analysis and specifications). This leads to re-analysis and re-design if (the inevitable) additional maintenance or enhancements are required, and even if the original resources are involved, they will not remember the workarounds and changes from the old system. Even worse, if there is re-development or conversion of a system, then the analysis and design has to be re-worked, instead of just new requirements added on.

11. **OU Scope:** As a result of the fact that our projects are not really standalone projects, but are part of a larger programme, this means that the assessment extends further into group information management, where IT's customer is actually a part of the development team, and the business managers, as well as the programme managers manage customer needs. The difficulty with this is that there needs to be complete communication between all parties involved. Often responsibilities and roles are not clarified and process execution is duplicated or not performed at all.

Although assessments were performed on specific process instances, they seem to be typical of the entire OU. So, the individuals which are part of the projects are not to blame (except if personal professionalism was an issue), but rather the system of which they are a part - there is no means of seeing the whole picture. You need to define EVERYTHING as a part of a system and process in order to do that.

6 Significance

This section discusses lessons learned and suggestions for improvement from all the assessments performed as part of the study.

6.1 Lessons Learned

Questions and problems were directed to the local trials co-ordinator and discussed at some of the meetings of WG10. The following were experiences from the SPICE assessment:

1. **Assessment Management:** Like any project, an assessment should be carefully planned, resourced, managed and tracked. Although most of this assessment was performed last year, the fact that all documentation had been kept up to date, meant that it was fairly easy to continue from where one had left off.

2. **Accuracy vs. Time:** In the ideal world you would want to interview every practice/process "user" and review every work product, but taking the Pareto Principle (to only perform 80% of the work, since the additional 20% will require as much effort, with little benefit) into account, you should be able to get a fairly accurate view from a good sample of people and work products. Further time reduction can take place if interviews are audio- or video taped and the assessor consolidates and reviews together with work products simultaneously later. Reviews are very tiring and should not exceed 3 hours a day. Timeboxing may be a good technique.

3. **Habits:** Interestingly, although projects vary, processes are like habits and most people remember how they performed a specific process.

4. **Honesty:** Interviewees appeared to be fairly honest (although some discrepancies were found, as a result of misunderstanding and/or miscommunication, rather than intentional misleading). It is expected that for an internal assessment, interviewees would continue to be

honest as long as the results were not to be used for personal measure. Generating accurate documented evidence (unless an ISO certificate depends on it) would be counterproductive, but for any assessment / test there is likely to be a way of cheating if interviewees are trained to answer in a specific way, but like all tests, the best way to pass is the honest and legal way.

5. **Capability Level Assessment:** At the higher levels, the assessment becomes more difficult, since evidence of management practice performance must be found. These were not assessed in detail, since it was limited to (usually) an outdated project plan, which had some activities on it, and then the main interviewee was usually able to say which were and were not implemented.

6. **Record Availability:** Difficult to perform post assessment if records from that point in time are unavailable e.g. correct version of Blue Book, rather than current version.

7. **SPICE Assessor Skills:** Recommended that a SPICE assessor have basic system knowledge i.e. analysis, design and construction, so that they are able to recognise dishonesty from an interviewee based on documented evidence. Also, auditing and software engineering skills are an advantage. A recommended skill set as you assess each process attribute level for capability levels is project management, quality and configuration management, standards (both international and OU) and resource and infrastructure management.

8. **SPICE Assessment Difficulties:** were experienced when assessing related or dependent practices. The large amount of time is spent on validation. Also, resource availability influences scheduling, and even advance planning does not ensure that interviewees or auditors will be available when required. A useful tool would be cross-check matrix between some of the practices and capability levels, although if you do the assessment within a short time frame, it should not be very hard to establish.

9. **SPICE Assessment Process:** Recommended to perform in the following order: For all interviewees: (1) Conduct interview and collect ALL work products, (2) Review interview and work products and assign ratings, (3) Confirm with interviewee, (4) Audit and confirm with external auditor.

6.2 Recommendations

The following general approaches can be taken:

1. **Action Plan with Approval:** The next process improvement step should be taken, but not in terms of this individual project, but rather as a larger initiative across the department. Management should approve the areas for improvement, goals and targets and thereby actively commit the OU to the process improvement. An action plan should be put together describing the set and priority of actions to improve software processes.

2. **Root Cause Analysis:** A complete impact analysis could be done to determine the main root causes of the problems. They not only have a negative effect on the process, but also on the people and technology too. Elimination of these should become a priority and would derive the greatest benefit.

3. **By Osmosis:** Use some of the lessons learned and techniques within the programme Architecture team to introduce changes to the entire OU.

4. **Increased Capability Levels:** In order to achieve level 2 and higher, base practices must be documented in a common process framework, with individual and team *tailoring* also being noted in a commonly identified document. Also, all work products must be under configuration management. We then run into the difficulty that you will no longer be able to maintain the speed of delivery, since you have additional work products to be delivered to your OU and not to your customer. However, eventually these work products should have standard templates and should influence later work which would require less planning and more implementation time, as the standard plan templates should exist and just require minor tailoring. Also, resources will have the required process experience to understand what needs to be done when, and will almost execute out of habit, without requiring a defined plan (although the project manager must still track this). If a workshop is supposed to cover managing customer needs, QA, verification and developing system requirements, then there should be a standard checklist, so that it will meet all those requirements. Such a project requires at least a 2-year commitment.

As a start, one or more of the following actions could be taken, taking the OU's business goals and objectives into consideration:

1. **Process Roles:** Define process owners and process stakeholders.

2. **Process Deployment:** Identifying an integrated, standard set of processes, which are available in a

standard format in a standard area. Existing processes should be deployed and training or standards on related tools (e.g. timesheets) should be given to all process users. SPICE could be used as the common framework. These should then be monitored, controlled, audited and continually improved.

3. **Process Change Management:** Define change management process and roles and responsibilities for standard processes i.e. ATACC, EDM, MPO.

4. **Process Tracking:** Accurate record keeping from timesheets would assist in future planning and estimation efforts and impact analysis.

5. **Maintenance Process:** Alternately, change focus, use Phoenix as basis, and then re-define process for 'small developments' or maintenance (similar to micro function points) i.e. investigate and establish a common process framework.

6. **A Work Product Archive:** should be defined and created, where deliverables of each software development phase of a project including source code, project history and categorised lessons learned are stored for future reference. Project plans should also be submitted and consolidated across the OU, giving a good resource usage and availability tracking mechanism. These must be all under strict configuration management including auditing.

7. **Requirements Specification:** Using EDM with the requirements specification document template for capturing functional and non-functional specs (under review for inclusion in MPO), all requirements can be captured and used for auditing purposes. This will allow project managers to focus only on contractual obligations and enforce better requirements definition and change control, not only in terms of functionality, but 'quality' too.

8. **Change Control:** Although the template mentioned in the previous point would try to assist by listing all possible considerations, requirements will always change as a result of some omissions or ignorance. These changes will always need to be controlled i.e. a good change control methodology must be in place. This would assist with contract re-negotiation.

9. **Eskom Supplier Standards:** would greatly improve development and testing, as it is clearly impossible to test for endless possibilities and limiting hardware/software to some preferred suppliers would allow one to set up a test lab in which all performance testing could be properly run.

10. **Intermediate Deliverables:** Process outputs should be additional product outputs i.e. define that we require actuals to be recorded correctly for future planning, require lessons learned to be documented for input into other projects, require contributions to reuse libraries etc.

11. **Professionalism:** People should be professional enough to recognise the impact of their actions on the rest of the system. System being supervisor, team members (any number of teams - programmes, technical, customer etc.), customer, subordinates. This is a personal responsibility and is not a skill which can be taught.

12. **Communication Procedures:** The large number of roles and parties involved in processes are not distinctly modelled in SPICE, but creates a considerable communication overhead. There may be a need to set up proper communication procedures within and external to the department, so that a single consistent message (under configuration management) is always sent out.

13. **Training:** Due to the nature of the skilling process, is important that all OU members use a mechanism such as the PDP to ensure that they continually renew their skills and are assigned to new projects to gain experience. There should be a minimum standard of education for each process role (e.g. systems analyst). Education will either be formal instructor-led, vendor-provided training or CBT training from IT Training. Self-study is not bad, but there is no way of seeing at what standard the knowledge is.

14. **Knowledge Sharing:** There must be a realisation that one is not being employed because of personal project knowledge, but rather the personal knowledge they can contribute to their peers, the department, their customers and Eskom. Continual re-work is the result of being unable to or refusing to share information. This has to be a conscious effort from management, team leaders and team members, but should probably start where it is most visible. Knowledge sharing groups should be set up, and each person should be expected (as a personal KPI) to contribute. Registers (e.g. contact persons for function point measurement) and procedures (eg. how to setup Windows 95 on a notebook) could be documented.

15. **SPICE Assessment Embedded Model:** Recommended to re-define or add to base practices, work products, resource and infrastructure to use

Eskom terminology and/or create common process framework using SPICE model (or ISO 12207).

7 Conclusion

On a final note, suggestions have been made and it is up to the process owners and assessment sponsor to decide on the actions to be taken. Individuals may also choose to improve their personal software process. This is a medium term initial commitment with long term benefits. Individuals may also choose to improve their personal software process.

As this is part of a larger study, the next step for the study is to establish, in conjunction with the other SPICE assessments:

1. insight provided by the footprint performance indicators into the capability level of an OU.
2. insight provided by the footprint performance indicators into the capability level of a process.
3. insight provided by the footprint performance indicators into the capability level of a process category.
4. insight provided by the capability level of an OU into the footprint performance indicators.
5. insight provided by the capability level of a process into the footprint performance indicators.
6. insight provided by the capability level of a process category into the footprint performance indicators.
7. limitations of SPICE covered by PEP.
8. limitations of PEP covered by SPICE.
9. limitations of both PEP and SPICE.

8 Acknowledgements

Thanks to all the people who participated and contributed to the assessment.

9 References

1. ISO/IEC 15504 Parts 1-9 v2.00
2. MLA326 SPICE Assessment Working Document for Projects C and D
3. MLA325 SPICE Assessment Quality Plan for Projects C and D

SPICE Assessment Feedback Summary

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1 Introduction

SPICE assessments were performed on the following 4 projects. These projects were selected because they met the requirements for the assessor's MLA Masters research project i.e. it was assessed in the CSC PEP Programme Cycle 2, and therefore had both function point counts and a PEP footprint available, as well as being used by a core Eskom business function and had no major problems regarding resource availability for interviews. Although only 3 were to be assessed, when interviews for SPICE began, one of the project teams had had two projects as part of the PEP Baselining and requested that their second project be included as well.

The tables below provides a summary of the chosen projects.

Table 1: Projects Summary

Project	Description
A	New 3-month standalone development on predominantly 4GL platform
B	New 6-month standalone development on predominantly 4GL platform
C	New 2-month integrated development on 4GL platform
D	New 2-month integrated development on 4GL platform

This document provides a summary of SPICE, the assessment methodology, the actual assessments, summary results obtained from the assessments and proposed enhancements to the existing processes.

2 Abbreviations

The following abbreviations are used throughout this document:

ATACC:	Advanced Test and Change Control
CASE:	Computer Aided Software Engineering
EDM:	Eskom Development Methodology
ITD:	Information Technology Department
MPO:	Macro Project Office
OU:	Organizational Unit
PEP:	CSC Performance Enhancement Programme
SPICE:	Software Process Improvement and Capability Evaluation

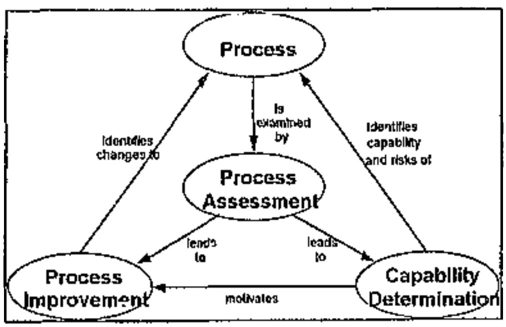
3 Software Process Improvement and Capability Determination

ISO/IEC 15504, also known as Software Process Improvement and Capability Determination or by the acronym SPICE is an international standard developed by ISO/IEC JTC1/SC7 WG10 to provide a structured approach for the assessment of software processes.

3.1 The SPICE Model

The model adopted by ISO/IEC 15504 is shown in Figure 1. Fundamental to the model is the concept of a process, which is described as *a set of interrelated activities, which transform inputs into outputs.*

Figure 1: The Assessment Process

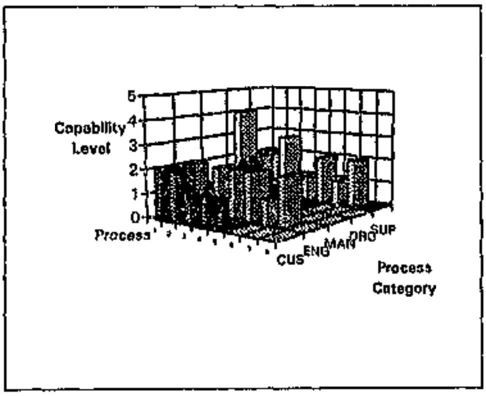


Processes are examined using the mechanism of process assessment, defined as *a disciplined evaluation of an organisation's software processes.* The output of the assessment exercise is a profile, which can be used variously for process improvement (*Action taken to change an organisation's processes so that they meet the organisation's business needs and achieve its business goals more effectively*) and/or for determination of process capability - *a systematic assessment and analysis of selected software processes within an organisation against a target capability, carried out with the aim of identifying the strengths, weaknesses and risks associated with deploying the processes to meet a particular specified requirement.*

The two key components of the standard are a process model and guidance on conducting assessments.

The process model is made up of a framework of attributes in two dimensions: The Process dimension contains process categories, processes and base practices, and the Capability dimension contains capability levels, process attributes and management practices. Input and output work products are used as indicators of level of achievement of base and management practice.

Figure 2: The Dimensions of the SPICE Model



3.2 The SPICE Process Categories

Processes are grouped into general areas of activity called process categories:

1. Customer-Supplier (CUS)
2. Engineering (ENG)
3. Support (SUP)
4. Management (MAN)
5. Organization (ORG)

The processes in Figure 2 are enumerated for illustrative purposes, but they are not the same across all the process categories.

3.3 The SPICE Capability Levels

A capability level is *a set of process and management attribute(s) that work together to provide a major enhancement in the capability of a Supplier to perform a process.*

Each level provides a major enhancement of capability in the performance of a process. The levels constitute a rational way of progressing through improvement of the capability of any process.

There are six capability levels in the reference model.

As you progress up the capability maturity scale, you transform from not performing the process (level 0) to solely performing the process (level 1) to managing it at a team-based level (level 2) to using a defined organisation-wide process (level 3) to measuring it, and using it for effective prediction and process control (level 4) and then finally to optimising it (level 5).

The capability level of each process is independently assessed, by an assessor making a judgement supported by documented objective evidence. This may be based on practice attributes (by interviewing process practitioners and managers) or work product characteristics (by examining documents, plans etc.) provided by the SPICE embedded model. This leads to a collection of profiles which represent the assessment output, as seen in Figure 2.

A first assessment can form part of a baseline and then using the Guidelines for Process Improvement, improvements can be prioritised and implemented in accordance with organisational goals.

SPICE is a relatively new standard and is still undergoing development and phase 2 trials.

4 SPICE Assessment Methodology

This section details information additional to the standard SPICE Methodology as represented by the SEAL Of Quality v0.82 tool. Both the instrument and the methodology are SPICE compatible.

4.1 Assessment Input

The following people were involved in the assessments:

1. Erich Roberts was the sponsor and owner. A sponsor internal to the OU.
2. Melanie Lang was the qualified assessor responsible for the assessment.

3. Available process and project resources were the interviewees.

4. Christine Griesel was the internal auditor.

5. Prof. Walker was the external auditor

Refer to each Assessment Quality Plan (MLA305, MLA315, MLA325) for further detail on their responsibilities.

The purpose of the assessments was to provide a profile for comparison against the function point count and PEP footprint, providing additional insight into processes in other words a process assessment rather than for capability determination.

The assessment approach was self (performed by a member of the organisational unit), discrete (a 'snapshot at a point in time) and team-based (no automated tool was used, but a group was involved).

The assessment type was full (covering all processes), basic (without adding additional processes to the SPICE set) and initial (no previous assessment had taken place.

The scope of the assessments was all the processes, excluding Acquire Software and Manage Subcontractors (Operate Software was excluded in Project A, Maintain Software in Projects A and B), up to capability level 3 (Established Process) where applicable within Eskom IT Application Systems (about 200 people). Reasons for limiting this scope is that as a result of these being assessments with an internal sponsor, the sponsor would only have control of those areas he managed and very few processes were expected to be at level 2 and even less at level 3.

Main constraints included:

- the availability of key resource and maximum amount of time to be used for each assessment. This was restricted to +- 1 hour for 7 days for the main interviewee;

- confidentiality agreements protected the identity of an interviewee outside the SPICE Assessment Team.

4.2 Assessment Approach

The assessment schedule involved Preparation and planning (of the assessment input and project and quality plans); Assessment and Analysis (with the identified resources and auditing with identified experts); and Close-Out and Reporting (Presentation to all involved). All 3 assessments were to run in parallel, but due to various interviewee constraints, project A was completed first and projects C and D last.

4.3 Assessment Assumptions

The following assumptions were made during the assessments:

1. The assessments were conducted as far as possible with the project leader, and the assessment ratings were validated by reviewing the available documentation and cross-checking certain practices with other resources.

2. Most of the Organisation process category focussed on a much higher level, and was covered by the upper managerial roles, rather than the junior ones.

3. The main focus of each assessment was the Engineering and Customer-Supplier categories, but with the additional time, it was decided to complete the entire profile.

4. As these were discrete assessments, it was essentially a snapshot of the processes at a point in time after the function point count had been done, and which was covered by the information in the PEP data capture forms. This meant that processes which may have been used later on in the year, were not assessed.

5. Due to the informal nature of the project, base practices were examined mainly on the basis of trust, rather than expected documented evidence, however, where documents were available, they were informally examined, although not rated, and listed in each Assessment Working Document (MLA306, MLA316, MLA326).

6. Main project members were available for interviews, but rather than them being 100% available for a week, the assessor had to be available to accommodate them. As a result of the time and this resource constraint, only the developer, project manager, MPO project leader, IT training manager, group systems application managers and applications manager were interviewed, and problems arose where areas were covered strictly by other project roles, although the project managers view was taken as objectively as possible. It was thus assumed that the project manager was aware of most of the procedures followed, and problems encountered during the project, and could provide the most accurate view of the processes.

4.4 Assessment Risks

The following risks were considered throughout the assessment:

Table 2: Assessment risks and planned approaches

Risk	Management
The assessment may cross boundaries into areas which are not covered by the scope i.e. IT Application Systems.	Where possible, these processes were omitted from the assessment, as they were processes which were not under the control of the sponsor, and no changes to them could have been made. This meant that the next level of the assessment e.g. for the base practices, the process ratings would be adjusted to exclude that practice aggregation.
The size of the group of project resources, who each work on several areas, may cause problems in terms of coverage of the processes and capability levels.	The major source of information for doing the assessment was the project manager, supported by the documents in the project folder.
The assessment team made use of the existing documentation that has been created to confirm the assessment rating. There was insufficient time to review every document that has been created.	A combination of interviews and investigation of the documents were used to do the assessment. It will be taken on trust that what has been stated and submitted by the assessment participants is true and correct.

5 SPICE Assessment Findings and Analysis

This section presents the profiles of each process category and summarises findings. For detailed evidence and ratings, consult each Assessment Working Document (MLA306, MLA316, MLA326).

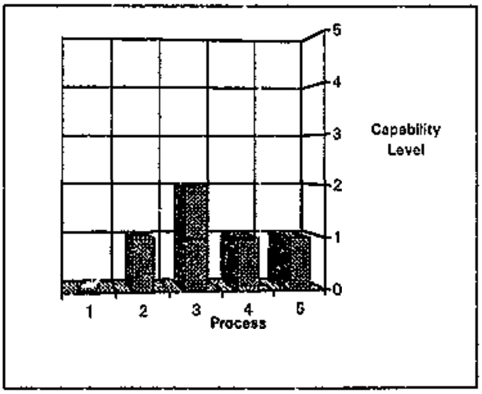
This section is in the following format:

- For each process category,
    - Description
    - Summary graph of process category
    - Summary of supporting evidence and findings
- Summary of findings
    - Summary graph
    - Summary of assessment findings

5.1 Customer-Supplier Process Category

These are *processes that directly impact the customer, support development and transition of the product to the customer, and provide for its correct operation and use.* They include: (1) Acquire software, (2) Manage customer needs, (3) Supply software, (4) Operate software and (5) Provide customer service.

Figure 3: Customer-Supplier Process Category



1. Acquire Software was excluded from the assessment, as it was assumed that the customer had defined the need, business case and then approached IT with high level requirements, as one of the possible suppliers to produce a suitable contract.

2. Informal communication with customer's requirements document and informal reviews assisted in all projects to Manage Customer Needs.

3. Software Supply ranged from level 1 to level 2. Level 2 was achieved by the project which supplied only to a single customer with a single resource assigned to installation and delivery.

4. Software Operation was excluded from the assessment of one project, and achieved level 1 on

all other projects, since the user was involved to a great extent on all stages.

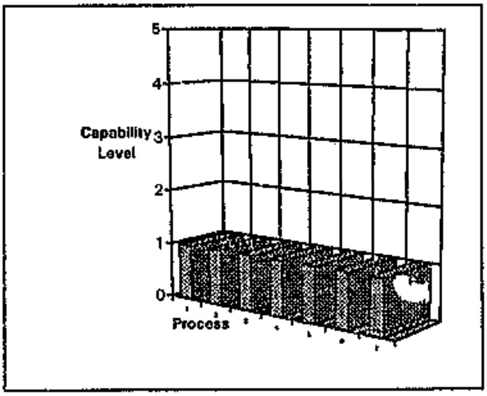
5. Training, support and customer service was fairly well managed. Some projects made use of Customer Care (Eskom IT's one stop customer service). Performance monitoring was performed in some cases, as well as benchmarking. Customer satisfaction was performed at the higher levels and sometimes at the project level by the team leader.

Generally, there was a fairly good relationship between customer and team facilitating this process, but a different team and/or customer may not have resulted in the same assessment. Most base practices are performed. Minimal configuration management would make it difficult to repeat.

5.2 Engineering Process Category

These are *processes that directly specify, implement, or maintain a system and product and its user documentation.* They include: (1) Develop system requirements and design; (2) Develop software requirements; (3) Develop software design; (4) Implement software design; (5) Integrate and test software; (6) Integrate and test system; and (7) Maintain system and software.

Figure 4: Engineering Process Category



1. It was often difficult to distinguish between system and software as indicated by developing system and software requirements and testing system and software. Although these are clearly different, they are often treated as the same process.

2. One or two documents were developed, but usually not fully maintained. Well-defined requirements with controlled changes prevented scope creep in one project.

3. Three of the projects made use of Oracle Designer/2000, but at the programme level - this did not always filter down to the software design and implementation level, especially when they were 'subcontracted'.

4. Some of the projects made use of Eskom Development Methodology tailored for their use, but the tailoring was never communicated beyond the team, so improvement of the original process would not have taken place.

5. Existence of a formal architecture, various standards and a number of resource libraries often assisted on these projects. These resource libraries were usually only known to the immediate team, and people external to the team would not have this advantage. Some projects used PVCS for code version control.

6. Prototyping was used in some cases, which assisted the users who were unable to visualise the system, however, it is a very difficult process to control.

7. Software code was often thought to be self-documenting as a result of the tools used, and the code comments. Although this may be the case, the risk of losing the source code as a result of the lack of configuration management should indicate a need to document in some other form too.

8. Although some projects had test schedules and test cases, none of the projects used a formal testing process. Most of the testing appeared to be driven by the user, and with a different user, it would be likely that the same results would be unachievable.

9. Traceability seems to be a fairly difficult aspect. There is nothing to track a requirement through the various stages all the way to testing, particularly if it is introduced at a late stage either introducing scope creep which should trigger contract re-negotiations.

10. The scope of two of the projects excluded maintenance, but the other two was a result of a design change and a business process improvement, which followed similar development process.

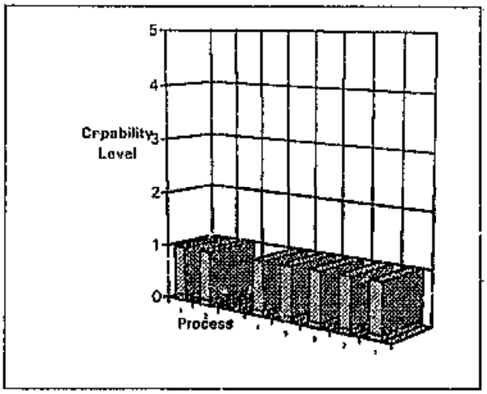
11. Time pressures often result in team members cutting corners, not always by choice, but due to pressures from other managers or leaders.

The Engineering process category is performed; placing all of the assessed processes on level one. Processes were dependent on the team. The standard process consisted of customised EDM. The strengths of this process are the general usage of SE principles. The weaknesses of this process are the lack of configuration management and in some cases, quality management on work products apart from the software code units (standard formats, verification and validation; version control.

5.3 Support Process Category

These are *processes that may be employed by any of the other processes (including other supporting processes) at various points in the product development life cycle.* They include: (1) Develop documentation; (2) Perform configuration management; (3) Perform quality assurance; (4) Perform work product verification; (5) Perform work product validation; (6) Perform joint reviews; (7) Perform audits; and (8) Perform problem resolution.

Figure 5: Support Process Category



1. The formal documentation requirements, where defined centred around the Oracle CASE models. No formal process for other developed documents existed. Informal reviews (as a result of minutes taken) and maintenance took place on some projects.

2. If a configuration management system and library existed for any of the projects, it was basically limited to PVCS on software code. The network server was used as a repository for documents, if they existed, as well as the CASE database. KP29's (Change requests as defined in Eskom's change process) were sometimes used to track code changes.

3. Quality assurance, work product verification and validation was mainly performed on the code units through informal reviews and testing with functionality being the main or only criteria, but not on the software engineering activities. Records were not usually kept, except for test results, in some cases. The project which had more formal reviews with a range of end users achieved level 1 for verification while the others were on level 0.

4. Management and technical reviews were done (in some cases more formally than others), however software process assessments were not done.

5. Two or less audits were performed on projects. However, for those projects which had audits performed, this process fell outside the OU.

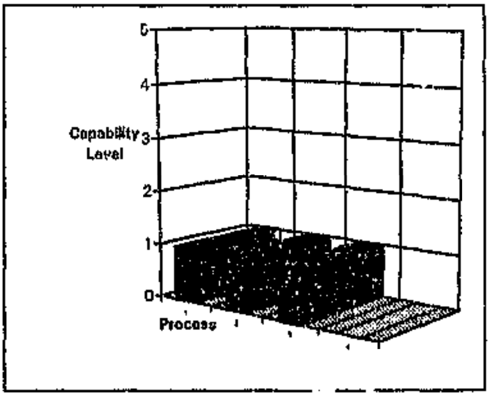
6. Problem resolution was also fairly mature as the customer was in direct contact with the project team and problem details, prioritisation, resolution and tracking was done informally. Defect correction and distribution was performed. Defect analysis was only performed on one project for severe problems. ARS (Eskom IT's Production problem management system) and SLA's (Service Level Agreement between customer and IT) were used by 2 of the projects.

The results of the assessment for this process category covered a wide range depending on which of the base practices were performed. The strengths of this area consist mostly of the fact that customer communications enhanced testing, joint reviews and problem resolution. The major weaknesses are that record keeping (i.e. change records, verification and validation test results, problem analysis, configuration item tracking and history) is not always done. Variation should be reduced by defining a minimum number of support processes such as specific verification or validation phases and minimum documents and configuration management practices.

5.4 Management Process Category

These are *processes that contain practices of a generic nature which may be used by anyone who manages any sort of project.* They include: (1) Manage the project; (2) Manage quality; (3) Manage risks; and (4) Manage subcontractors.

Figure 6: Management Process Category



1. Scope of work, project estimates, work breakdown structure, project schedule, infrastructure requirements were performed, using MS Project project plan(s). In one case, there were multiple levels of management with "sub-project" plans. Consolidation and central storage of project plans was not done. Project management of two projects was largely controlled by the customer, creating difficulties for the team. Although this ensured that specific quality criteria were met, it was likely that IT specific criteria had to be forfeited to meet these.

2. Only the programmes had resources assigned to quality and risk management, as well as some strategy, however, one programme had a team working on quality while the other had part of the time of a single resource. Similarly with risk management, one programme had a person assigned to this, and the other had part of the resource's time.

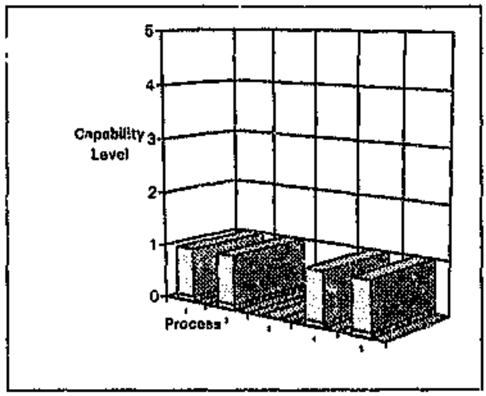
3. No subcontractors were managed.

The project management process is performed, but not all base practices. More formal management is required in the areas of quality and risk.

5.5 Organization Process Category

These are *processes that establish the business goals of the organisation and develop process, product, and resource assets which, when used by the projects in the organisation, will help the organisation achieve its business goals.* They include: (1) Engineer the business; (2) Define the process; (3) Improve the process; (4) Provide skilled human resources; and (5) Provide software engineering infrastructure.

Figure 7: Organization Process Category



1. A strategic vision was established for the organisational unit, but not many people seemed to be aware of it, indicating a problem with deployment. The appointment of a quality advisor (and quality resources at the programme levels) and subscription to an international benchmarking programme was considered to be the starting point of establishing a quality culture. Teams within programmes were integrated project teams. Formal incentives for the project were not provided, other than the existing ones. Recognition / rewards are based on end product rather than process outputs (End product is usually considered to be a working system - process outputs are intermediate deliverables, which would indicate a well-documented system which is easily maintainable and possibly contributes to future projects). For those who chose to participate, there was a Personal Development Plan (PDP) for career development.

2. This project was not used specifically to either define or improve existing OU processes, although it (among others) could have been one of the contributing factors to future process definition. Processes which were being defined at this time was Advanced Test and Change Control (ATACC) for Eskom's standard test and change control process and Macro Project Office (MPO) for

Eskom's standard project management process. One programme tried to introduce processes through weekly information meetings. The base practices were mostly partially to largely performed with no policy for it's use and no performance expectations. Process measures took the form of PEP Baselining and function point counting. One programme also had additional measures. Human resources for supporting process definition were informally defined and provided through the assigned programme quality resources, MPO resources and the Quality Advisor.

3. As the processes for MPO and ATACC were currently undergoing definition in the timeframe assessed, these processes would improve the current practices. However, for the Eskom Development Methodology (EDM) which had been defined prior to this timeframe, improving the process would mean improving the EDM itself. There were no formal plans, resourcing, standards or process infrastructure for future process improvements i.e. it appears to be ad hoc, and not a direct result of organisational goals. One programme performed a process assessment on EDM, but this was not widely communicated. Another had an object orientation pilot project.

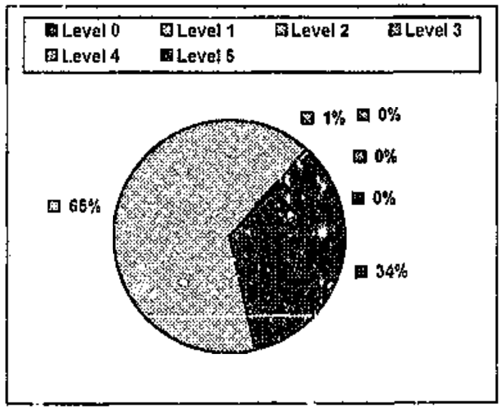
4. PDP's and business plans were used to identify human resource needs. These were used by the training department to acquire training. courses Programmes had specific training requirements. Project teams are defined and available resources with the necessary skills are selected, otherwise the recruitment process is started. The Personal Performance Contract, Job Output Models and Performance Appraisals are used to evaluate staff performance and feedback then given. Good personnel records are kept, no formal training records are kept and skills information was previously kept in the EDCO system but is now outdated. Empowerment and team interactions are not formally defined, except in the programmes.

5. Software engineering infrastructure are limited to technology specific issues and physical infrastructure. Some team standards exist. A reuse library mostly in the form of code or component libraries is partially in place in most projects, however not organization wide or as a formal part of the life cycle.

This process category was sometimes difficult to assess on a project level, and was taken on a much broader view. For the Provide Skilled Human Resources process, SPICE suggests that training and skilling is the responsibility of managers, however the OU took a human-centred approach, where each individual is responsible for him/herself and empowered to make their own decisions. This may be the reason that it performed better than the others. This process category was sometimes difficult to assess on a project level, and was taken on a much broader view. For the Provide Skilled Human Resources process, SPICE suggests that training and skilling is the responsibility of managers, however the OU took a human-centred approach, where each individual is responsible for him/herself and empowered to make their own decisions. This may also be the reason that it performed better than the others. This may be the reason for unsuccessful deployment of other processes. The fact that people are empowered, means they manage and control their own decisions and their subordinates, so instead of having to obtain commitment from 1 manager, the process deployment teams have to obtain commitment from 200 'managers'. Although processes are defined, there is no arrangements for future improvements. Infrastructure by means of organisation-wide standards and resource libraries (of all configuration items) did not exist, but was provided for the physical and language software engineering environments. Although processes are defined, there is no arrangements for future improvements. Software engineering infrastructure has been provided more for technical and physical environment, rather than standards and various resource libraries (not only code, but documents too) at the organisation-wide level. Programmes seem to have made more provision for the libraries and standards. One programme had a high degree of team coordination, cooperation and transparency and most of their processes were at level 1.

5.6 Summary

Figure 8: Derived SPICE Profile



1. **Capability:** Aggregated, the projects are mainly at capability level 1, performing a large number of the base practices. As a result of processes not existing, or the one's being used on the project not

being documented, the project would not be repeatable. Most of the teams making use of the processes will never achieve higher than level 2. The crux of level 1 are that processes are not dependent on individuals, i.e. if someone else in the team had to be given the same project, they would be able to achieve the same level, apart from several individualistic areas where they may be stronger or weaker. Level 3 is dependent on the fact that anyone in the department would be able to take on the project and not specifically the team involved. This of course would take into consideration management practice 2.1 that an individual with the required skills was chosen. However, the fact that the Engineering processes had the most highly skilled resources may indicate that individuals have to acquire skills in the other SE processes (eg. manage quality, develop documentation). This would also mean that it would not make a difference if anyone else in the OU had been managing eg. quality instead, since they would have had as much skill as another person.

2. **Experienced Resources:** The projects assessed definitely had highly proficient and skilled resources who did not necessarily need processes to ensure best practices, but the lack of correct documentation would make it difficult in future for maintenance. The nature and experience of the team made them inadvertently follow basic software engineering practices, but nothing formalised, or documented, which would lead to a repeatable process. These software engineering practices were also more easily planned, tracked and managed than the support and management category practices.

3. **Service Provision:** Eskom projects appear to be highly pressurised, where customer requests are often satisfied without regard for what may be 'healthy' for the OU. OU members seem to be condemned to a service provider role (except in one-off projects). This situation is a hindrance to proper planning, tracking and management since unplanned for emergencies interfere with work which cannot be rescheduled. This forces project resources to work long hours, often with no additional reward. This could have an effect on employee (dis)satisfaction.

4. **Size Counts:** The fact that the systems are rather small has a positive impact, since they appear to be easier to plan and manage, although constraints remain severe.

5. **Process Owner:** A major problem is that there is no clear definition of who owns / is responsible for which part of most processes.

6. **Existing Procedures and Libraries:** The fact that there are a number of procedures and even resource libraries that have been defined was a pleasant surprise. Unfortunately, they are not widely enough available or in some cases, are rejected by process users as being too broad to be applicable. Standalone projects are usually thought to be fairly simple and not requiring processes, however existence of standard departmental processes, architecture and various libraries of resources would not only speed up development, but also assist in maintenance. Engineering process category standards are centralised in the 'Blue Book' (Phoenix programme's database standards).

7. **Feedback Loop:** For the existing standard processes, there is currently no mechanism in place for those who use it (and possibly tailor it) to provide feedback to the owners, so that they can be modified, or the tailoring can be noted as a possibility. Although the processes state that they should be re-looked at every half-year, this does not happen, as there is no responsibility assigned for this.

8. **Pilot Process Projects:** Different requirements of each site makes using a pilot project to test a process difficult. It is important to take the pilot site's problems into account in context with the influence and requirements of the rest of the OU. Processes could be beta tested where responsible parties within all (development and maintenance) teams gather observations from within their programmes or their functional areas and communicate these to the process definition and improvement change control administrator. This would then be incorporated into each project's plan.

9. **Intangible System:** Prototyping is used as the excuse when requirements cannot be gathered for a system, but if a system is supposed to fulfil a business function regardless of the technology or the interface, this should be able to be gathered during analysis and design and during detail design, interface and other issues may be considered. This is a problem with both user and development teams, since the user is usually unable to visualise and developers are unable to explain a virtual system. It is important that "visionary" users and business analysts be involved at the requirements level and that "visionary" users, business and system analysts be involved at the detail design level. This will mean that a project

can move through a waterfall model and not require as much rework as continual re-development will require.

10. **Maintenance of Work Products:** In general, projects are fairly well done and documented as far as allowed i.e. if a customer demands a delivery date, the resources do as much as possible by that date, but documentation is often not considered to be of as high a priority, particularly when a project is timeboxed. There is a tendency after moving to the next phase to ignore maintenance of output work products or deliverables from previous phases (e.g. changes noted in minutes, must be recorded as change requests, and updated in code, test data, design, analysis and specifications). This leads to re-analysis and re-design if (the inevitable) additional maintenance or enhancements are required, and even if the original resources are involved, they will not remember the workarounds and changes from the old system. Even worse, if there is re-development or conversion of a system, then the analysis and design has to be re-worked, instead of just new requirements added on.

11. **OU Scope:** As a result of the fact that our projects are not really standalone projects, but are part of a larger programme, this means that the assessment extends further into group information management, where IT's customer is actually a part of the development team, and the business managers, as well as the programme managers manage customer needs. The difficulty with this is that there needs to be complete communication between all parties involved. Often responsibilities and roles are not clarified and process execution is duplicated or not performed at all.

Although assessments were performed on specific process instances, they seem to be typical of the entire OU. So, the individuals which are part of the projects are not to blame (except if personal professionalism was an issue), but rather the system of which they are a part - there is no means of seeing the whole picture. You need to define EVERYTHING as a part of a system and process in order to do that.

6 Significance

This section discusses lessons learned and suggestions for improvement from all the assessments performed as part of the study.

6.1 Lessons Learned

Questions and problems were directed to the local trials co-ordinator and discussed at some of the meetings of WG10. The following were experiences from the SPICE assessment:

1. **Assessment Management:** Like any project, an assessment should be carefully planned, resourced, managed and tracked. Although most of this assessment was performed last year, the fact that all documentation had been kept up to date, meant that it was fairly easy to continue from where one had left off.

2. **Accuracy vs. Time:** In the ideal world you would want to interview every practice/process "user" and review every work product, but taking the Pareto Principle (to only perform 80% of the work, since the additional 20% will require as much effort, with little benefit) into account, you should be able to get a fairly accurate view from a good sample of people and work products. Further time reduction can take place if interviews are audio- or video taped and the assessor consolidates and reviews together with work products simultaneously later. Reviews are very tiring and should not exceed 3 hours a day. Timeboxing may be a good technique.

3. **Habits:** Interestingly, although projects vary, processes are like habits and most people remember how they performed a specific process.

4. **Honesty:** Interviewees appeared to be fairly honest (although some discrepancies were found, as a result of misunderstanding and/or miscommunication, rather than intentional misleading). It is expected that for an internal assessment, interviewees would continue to be honest as long as the results were not to be used for personal measure. Generating accurate documented evidence (unless an ISO certificate depends on it) would be counterproductive, but for any assessment / test there is likely to be a way of cheating if interviewees are trained to answer in a specific way, but like all tests, the best way to pass is the honest and legal way.

5. **Capability Level Assessment:** At the higher levels, the assessment becomes more difficult, since evidence of management practice performance must be found. These were not assessed in detail, since it was limited to (usually) an outdated project plan, which had some activities on it, and then the main interviewee was usually able to say which were and were not implemented.

6. **Record Availability:** Difficult to perform post assessment if records from that point in time are unavailable e.g. correct version of Blue Book, rather than current version.

7. **SPICE Assessor Skills:** Recommended that a SPICE assessor have basic system knowledge i.e. analysis, design and construction, so that they are able to recognise dishonesty from an interviewee based on documented evidence. Also, auditing and software engineering skills are an advantage. A recommended skill set as you assess each process attribute level for capability levels is project management, quality and configuration management, standards (both international and OU) and resource and infrastructure management.

8. **SPICE Assessment Difficulties:** were experienced when assessing related or dependent practices. The large amount of time is spent on validation. Also, resource availability influences scheduling, and even advance planning does not ensure that interviewees or auditors will be available when required. A useful tool would be cross-check matrix between some of the practices and capability levels, although if you do the assessment within a short time frame, it should not be very hard to establish.

9. **SPICE Assessment Process:** Recommended to perform in the following order: For all interviewees: (1) Conduct interview and collect ALL work products, (2) Review interview and work products and assign ratings, (3) Confirm with interviewee, (4) Audit and confirm with external auditor.

6.2 Recommendations

The following general approaches can be taken:

1. **Action Plan with Approval:** The next process improvement step should be taken, but not in terms of this individual project, but rather as a larger initiative across the department. Management should approve the areas for improvement, goals and targets and thereby actively commit the OU to the process improvement. An action plan should be put together describing the set and priority of actions to improve software processes.

2. **Root Cause Analysis:** A complete impact analysis could be done to determine the main root causes of the problems. They not only have a negative effect on the process, but also on the people and technology too. Elimination of these should become a priority and would derive the greatest benefit.

3. **By Osmosis:** Use some of the lessons learned and techniques within the Phoenix Architecture team to introduce changes to the entire OU.

4. **Increased Capability Levels:** In order to achieve level 2 and higher, base practices must be documented in a common process framework, with individual and team tailoring also being noted in a commonly identified document. Also, all work products must be under configuration management. We then run into the difficulty that you will no longer be able to maintain the speed of delivery, since you have additional work products to be delivered to your OU and not to your customer. However, eventually these work products should have standard templates and should influence later work which would require less planning and more implementation time, as the standard plan templates should exist and just require minor tailoring. Also, resources will have the required process experience to understand what needs to be done when, and will almost execute out of habit, without requiring a defined plan (although the project manager must still track this). If a workshop is supposed to cover managing customer needs, QA, verification and developing system requirements, then there should be a standard checklist, so that it will meet all those requirements. Such a project requires at least a 2-year commitment.

As a start, one or more of the following actions could be taken, taking the OU's business goals and objectives into consideration:

1. **Process Roles:** Define process owners and process stakeholders.

2. **Process Deployment:** Identifying an integrated, standard set of processes, which are available in a standard format in a standard area. Existing processes should be deployed and training or standards on related tools (e.g. timesheets) should be given to all process users. SPICE could be used as the common framework. These should then be monitored, controlled, audited and continually improved.

3. **Process Change Management:** Define change management process and roles and responsibilities for standard processes i.e. ATACC, EDM, MPO.

4. **Process Tracking:** Accurate record keeping from timesheets would assist in future planning and estimation efforts and impact analysis.

5. **Maintenance Process:** Alternately, change focus, use Phoenix as basis, and then re-define process for 'small developments' or maintenance (similar to micro function points) i.e. investigate and establish a common process framework.

6. **A Work Product Archive:** should be defined and created, where deliverables of each software development phase of a project including source code, project history and categorised lessons learned are stored for future reference. Project plans should also be submitted and consolidated across the OU, giving a good resource usage and availability tracking mechanism. These must be all under strict configuration management including auditing.

7. **Requirements Specification:** Using EDM with the requirements specification document template for capturing functional and non-functional specs (under review for inclusion in MPO), all requirements can be captured and used for auditing purposes. This will allow project managers to focus only on contractual obligations and enforce better requirements definition and change control, not only in terms of functionality, but 'quality' too.

8. **Change Control:** Although the template mentioned in the previous point would try to assist by listing all possible considerations, requirements will always change as a result of some omissions or ignorance. These changes will always need to be controlled i.e. a good change control methodology must be in place. This would assist with contract re-negotiation.

9. **Eskom Supplier Standards:** would greatly improve development and testing, as it is clearly impossible to test for endless possibilities and limiting hardware/software to some preferred suppliers would allow one to set up a test lab in which all performance testing could be properly run.

10. **Intermediate Deliverables:** Process outputs should be additional product outputs i.e. define that we require actuals to be recorded correctly for future planning, require lessons learned to be documented for input into other projects, require contributions to reuse libraries etc.

11. **Professionalism:** People should be professional enough to recognise the impact of their actions on the rest of the system. System being supervisor, team members (any number of teams - programmes, technical, customer etc.), customer, subordinates. This is a personal responsibility and is not a skill which can be taught.

12. **Communication Procedures:** The large number of roles and parties involved in processes are not distinctly modelled in SPICE, but creates a considerable communication overhead. There may be a need to set up proper communication procedures within and external to the department, so that a single consistent message (under configuration management) is always sent out.

13. **Training:** Due to the nature of the skilling process, is important that all OU members use a mechanism such as the PDP to ensure that they continually renew their skills and are assigned to new projects to gain experience. There should be a minimum standard of education for each process role (e.g. systems analyst). Education will either be formal instructor-led, vendor-provided training or CBT training from IT Training. Self-study is not bad, but there is no way of seeing at what standard the knowledge is.

14. **Knowledge Sharing:** There must be a realisation that one is not being employed because of personal project knowledge, but rather the personal knowledge they can contribute to their peers, the department, their customers and Eskom. Continual re-work is the result of being unable to or refusing to share information. This has to be a conscious effort from management, team leaders and team members, but should probably start where it is most visible. Knowledge sharing groups should be set up, and each person should be expected (as a personal KPI) to contribute. Registers (e.g. contact persons for function point measurement) and procedures (eg. how to setup Windows 95 on a notebook) could be documented.

15. **SPICE Assessment Embedded Model:** Recommended to re-define or add to base practices, work products, resource and infrastructure to use Eskom terminology and/or create common process framework using SPICE model (or ISO 12207).

7 Conclusion

On a final note, suggestions have been made and it is up to the process owners and assessment sponsor to decide on the actions to be taken. This is a medium term initial commitment with long term benefits. Individuals may also choose to improve their personal software process.

As this is part of a larger study, the next step for the study is to establish, in conjunction with the other SPICE assessments:

1. insight provided by the footprint performance indicators into the capability level of an OU.

2. insight provided by the footprint performance indicators into the capability level of a process.

3. insight provided by the footprint performance indicators into the capability level of a process category.

4. insight provided by the capability level of an OU into the footprint performance indicators.

5. insight provided by the capability level of a process into the footprint performance indicators.

6. insight provided by the capability lev[illegible] [illegible]rocess category into the footprint performance i[illegible]ators.

7. limitations of SPICE covered by PEP.

8. limitations of PEP covered by SPICE.

9. limitations of both PEP and SPICE.

8 Acknowledgements

Thanks to all the people who partic[illegible] [illegible] and contributed to the assessment.

9 References

1. ISO/IEC 15504 Parts 1-9 v2.00

2. MLA306 SPICE Assessment Working Document for Project A

3. MLA305 SPICE Assessment Quality Plan for Project A

4. MLA316 SPICE Assessment Working Document for Project B

5. MLA315 SPICE Assessment Quality Plan for Project B

6. MLA326 SPICE Assessment Working Document for Projects C and D

7. MLA325 SPICE Assessment Quality Plan for Projects C and D

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MLA QMS

FPA Vs SPICE Comparison

Technical Product

Version 1.00

Document Status: Approved

Table of Contents

Change History

Configuration Control

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0.01	98\05\13	Additions to comparison section
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1.00	98\08\10	Approved	MLA 2031 section 2.9

Change Forecast

1 Scope

1.1 Introduction

After the data collection has been completed, these results have to be compared. This document will serve to capture comparisons and limitations.

1.2 Purpose

To document:

1. insight provided by the footprint performance indicators into the capability level of an OU.
2. insight provided by the footprint performance indicators into the capability level of a process.
3. insight provided by the footprint performance indicators into the capability level of a process category.
4. insight provided by the capability level of an OU into the footprint performance indicators.
5. insight provided by the capability level of a process into the footprint performance indicators.
6. insight provided by the capability level of a process category into the footprint performance indicators.
7. limitations of SPICE covered by PEP.
8. limitations of PEP covered by SPICE.
9. limitations of both PEP and SPICE.

Each section displays a table with the results, followed by sections with the headings Possibilities, Hypotheses and Summary. Possibilities details any possible correlations. Hypotheses details any possibilities which did not arise from the tables, but as a result of personal experience. Summary summarises the discussion.

1.3 Applicability

1.4 Definitions

1. Budget Conformance (bc) - How much the project is over or under its planned budget, and on how this compares with industry-wide figures.

2. Capability level - a set of process and management attribute(s) that work together to provide a major enhancement in the capability of a Supplier to perform a process. Each level provides a major enhancement of capability in the performance of a process. The levels constitute a rational way of progressing through improvement of the capability of any process.

3. Function Point Analysis (FPA)

4. Function Delivery Index (FDI) - Overall efficiency of project team which is a measure of the relationship between project size, time and effort.

5. Function Points/month (fp/m) - Speed of delivery.

6. Function Points/staff month (fp/sm) - How much is delivered for resource invested. This incorporates size and effort.

7. Level 0 (Incomplete) - There is general failure to attain the purpose of the process. There are no easily identifiable work products or outputs the process.

8. Level 1 (Performed) - The purpose of the process is generally achieved. There may not be evidence of rigorous project planning and tracking. Individuals within the organisation recognise that an action should be performed, and there is general agreement that this action is performed as and when required. There are identifiable work products for the process, and these provide evidence to the achievement of the purpose.

9. Level 2 (Managed) - The process delivers work products of acceptable quality within defined timescales. Performance according to specified procedures is planned and tracked. Work products conform to specified standards and requirements.

10. Mean Time To Failure (MTTF) - Average time between failures once a system is released into production.

11. Organisational unit (OU) - represents IT Application Systems, and not the business managers, customers or end users involved on the project.

12. Performance Enhancement Programme (PEP)

Table: Processes and process categories

Process Category		Process	
ID	Title	ID	Title
CUS	Customer Supplier process category		
		CUS.1	Acquire software
		CUS.2	Manage customer needs
		CUS.3	Supply software
		CUS.4	Operate software
		CUS.5	Provide customer service
ENG	Engineering process category		
		ENG.1	Develop system requirements and design
		ENG.2	Develop software requirements
		ENG.3	Develop software design
		ENG.4	Implement software design
		ENG.5	Integrate and test software
		ENG.6	Integrate and test system
		ENG.7	Maintain system and software
SUP	Support process category		
		SUP.1	Develop documentation
		SUP.2	Perform configuration management
		SUP.3	Perform quality assurance
		SUP.4	Perform work product verification
		SUP.5	Perform work product validation
		SUP.6	Perform joint reviews
		SUP.7	Perform audits
		SUP.8	Perform problem resolution
MAN	Management process category		
		MAN.1	Manage the project
		MAN.2	Manage quality
		MAN.3	Manage risks
		MAN.4	Manage subcontractors
ORG	Organization process category		
		ORG.1	Engineer the business
		ORG.2	Define the process
		ORG.3	Improve the process
		ORG.4	Provide skilled human resources
		ORG.5	Provide software engineering infrastructure

13. Schedule Conformance (sc) - How much the project is over or under its planned schedule, and how this compares with industry-wide figures.

14. Software Process Improvement and Capability Determination (SPICE)

15. Staffing Index (si) - Whether a project appears to be overstaffed, which is often an indicator of poor planning or unrealistic deadlines.

16. Technical Quality Index (TQI) - Errors detected during testing and early operation.

17. Value Adjustment Factor (VAF) - Data Communication (DC), Distributed Processing (DP), Performance (P), Heavily Used Configuration (HuC), Transaction Rates (TR), On-line Data Entry (ODE), Design for Enduser Efficiency (D), On-line update (OU), Complex Processing (CP), Usable in other Applications (U), Installation Ease (IE), Operational Ease (OE), Multiple Sites (MS), Facilitate Change (FC)

1.5 Audience

The audience for this document comprise the various stakeholders of the SEAL, including:

- The student undertaking this M.Sc. project.
- Interested members of Eskom IT, including my team leader, the IT Application Systems Quality Team and the IT Application Systems Manager.
- The supervisor of this M.Sc. project.
- Members of the SEAL Management Board
- Head of Department of Electrical Engineering
- Individuals who perform internal and external audits on projects undertaken within the SEAL Quality Management System.

1.6 Applicable Documents

1.6.1 Specifications

1.6.2 Standards

a. SEAL QMS Document Creation Template, QS 002, Revision 0.02, 3 October 1994

b. SEAL QMS Document Layout, Presentation and Typesetting Guide, QS 003, Revision 1.00, 3 October 1994

1.6.3 Procedures

1.6.4 Guidelines

1.6.5 Other Documents

a. FPA Documents

b. SPICE Documents

1.7 Assumptions

1.8 Requirements Traceability

2 Points to note

1. Projects B, C and D have the same aggregated capability levels.
2. The basis of a function point count is that it measures the size of a system delivered to a customer from the business point of view.
3. Most PEP projects are from organisations of capability level 1. About 80% of organisations are capability level 1.
4. Projects C and D are from the same team, but with different customers.
5. Projects B, C and D are parts of a larger programme. Project A was an independent project.

3 Analysis of data

3.1 Function Point Count <-> Capability Level of OU

			Capability Level (%)		
Project	**Analysis Count**	**Implementation Count**	**0**	**1**	**2**
C		89	27.59	72.41	0
D		128	27.59	72.41	0
A	146	172	51.72	44.79	3.49
B		307	27.59	72.41	0

3.1.1 Possibilities

1.1. Determining the functional size pre- and post- development provides a higher capability level. This is dependent on the usage of the pre-development function point count - if it is used within the processes to assist with estimation of projects and with managing customer's expectations, it would make a positive impact. This was not the case on project A, although it may have indirectly or unconsciously influenced the project manager's estimations.

1.2. Higher organisational unit capability level allows the p˙ cesses to be in place for determining pre- and post- development functional size.

3.1.2 Hypotheses

1.1. It is fairly clear that although projects B, C and D have the same percentage of capability levels, this has no relation to the size of the project. Even the largest project has a higher percentage of capability level 1 than level 0.

1.2. Projects with higher capability levels will be able to deliver systems of differing sizes and differing complexities (as indicated by general system characteristics) equally efficiently and with equal speed, cost and quality.

3.2 Function Point Count <-> Capability Level of Process

			Customer-Supplier				
Project	**Analysis Count**	**Implementation Count**	**1**	**2**	**3**	**4**	**5**
C		89	-	1	1	1	1
D		128	-	1	1	1	1
A	146	172	-	1	2	-	1
B		307	-	1	1	1	1

3.2.1 Possibilities

1.1. Assuming these are small sized systems, then small size produces a higher capability level for Manage Customer Needs and Provide Customer Service. It would appear that a smaller sized system would be easier to manage with a customer, since any changes would have a smaller impact than a change to a larger system.

1.2. Assuming these are small sized systems, then a higher capability level for Manage Customer Needs and Provide Customer Service produces small sized systems. The only reason would be if the project was timeboxed and less functionality was delivered due to customer service and relationship management.

1.3. Determining the functional size pre- and post- development provides a higher Supply Software capability level. This is dependent on the usage of the pre-development function point count - if it is used within the processes to assist with estimation of projects and with managing customer's expectations, it would make a positive impact. This was not the case on project A. The case of the 'Supply Software' capability level seems to be incidental.

1.4. Higher Supply Software capability level allows the processes to be in place for determining pre- and post- development functional size. This does not seem to have a reason. The case of the 'Supply Software' capability level seems to be incidental.

3.2.2 Hypotheses

1.1. A system delivering no business value, which then could be size zero, should have a Level 0 Customer-Supplier process. This is an abstract notion, since it is unlikely that any reasonable business will deliver such a system.

			Engineering						
Project	Analysis Count	Implementation Count	1	2	3	4	5	6	7
C		89	1	1	1	1	1	1	1
D		128	1	1	1	1	1	1	1
A	146	172	1	1	1	1	1	1	-
B		307	1	1	1	1	1	1	-

3.2.3 Possibilities

1.1. The higher implementation counts did not have 'Maintain System and Software' assessed. This could indicate that a large portion of the implementation of the smaller sized system was actually maintenance or that the maintenance cycles were excluded from the projects with the larger functional sizes, since any system changes were included in change control. It might also be as a result of the processes on the programme which projects C and D were part of. The reason for this could be that a large system would complete either development or maintenance within the interval of a year, which was the time span of a PEP cycle, so the project would either be assessed as a development or a maintenance project.

1.2. Assuming these are small sized systems, then small size produces a higher capability level for Software Development. This could support the fact that smaller systems are easier to control and allow one to concentrate on the primary processes of software development.

1.3. Assuming these are small sized systems, then a higher capability level for Software Development produces small size. The only reason would be if the project was timeboxed and less functionality was delivered due to software development management.

3.2.4 Hypotheses

1.1. None

			Support							
Project	Analysis Count	Implementation Count	1	2	3	4	5	6	7	8
C		89	0	0	0	1	1	1	0	1
D		128	0	0	0	1	1	1	0	1
A	146	172	0	0	0	0	1	1	0	1
B		307	1	1	0	1	1	1	1	1

3.2.5 Possibilities

1.1. The larger sized system causes a higher capability level for Develop documentation, Perform configuration management, and Perform audits. This may be a result of the programme being in place for a longer time, and having the processes in place, rather than any relation to size. The only reason is that a smaller system requires less support mechanisms, where the mechanism could be the documentation, configuration management and audit processes.

1.2. Assuming these are small sized systems, then small size produces a higher capability level for Perform work product validation, Perform joint reviews and Perform problem resolution. The only plausible reason is that a smaller system requires less support mechanisms, where the mechanism could be the validation, joint review and problem resolution processes.

1.3. Assuming these are small sized systems, then a higher capability level for Perform work product validation, Perform joint reviews and Perform problem resolution produces small size. The only reason would be if the project was timeboxed and less functionality was delivered due to validation, review and problem resolution, which could have caused rework.

1.4. Assuming these are small sized systems, then small size produces a lower capability level for Perform work product verification. As opposed to the processes in 1.4, validation is not directly detectable by a customer, unless the customer performs thorough testing or usage of the system. This could imply that small size is believed to require less formal testing.

1.5. Assuming these are small sized systems, then a lower capability level for Perform work product verification produces small size. The only reason would be if the project was timeboxed and less functionality was delivered due to a low capability verification process, which could have caused rework.

3.2.6 Hypotheses

1.1. None

			Management			
Project	**Analysis Count**	**Implementation Count**	**1**	**2**	**3**	**4**
C		89	1	1	0	-
D		128	1	1	0	-
A	146	172	1	0	0	-
B		307	1	0	1	-

3.2.7 Possibilities

1.1. The smaller sized systems had a higher capability level for 'Manage Quality'. It might also be as a result of the processes on the programme which projects C and D were part of. The rationale behind this may be that a smaller system requires less control mechanisms, where the mechanism could be the quality management processes.

1.2. The largest size system had a higher capability level for 'Manage Risks'. It might also be as a result of the processes on the programme which projects B were part of. The rationale behind this may be that a larger system requires more risk management mechanisms.

1.3. Assuming these are small sized systems, then small size produces a higher capability level for project management. This could support the fact that smaller systems are easier to control and allow one to concentrate on the primary processes of software development.

1.4. Assuming these are small sized systems, then a lower capability level for project management produces small size. The only reason would be if the project was timeboxed and less functionality was delivered due to a high capability project management process.

3.2.8 Hypotheses

1.1. None.

			Organisation				
Project	**Analysis Count**	**Implementation Count**	**1**	**2**	**3**	**4**	**5**
C		89	1	1	0	1	1
D		128	1	1	0	1	1
A	146	172	0	0	0	1	0
B		307	0	0	0	1	1

3.2.9 Possibilities

1.1. The smaller sized systems had a higher capability level for 'Engineer the Business' and 'Define the process'. It might also be as a result of the processes on the programme which projects C and D were part of. The smaller sized systems were not used for business re-engineering or process definition specifically, but possibly their size was an indication that these exercises or infrastructure had already been previously defined.

1.2. Assuming these are small sized systems, then there is a relationship between small size and a lower capability level for Improve the process. Possibly, small size would mean there is not enough time to institutionalise a process improvement. There is no reason why immature process improvement processes would result in a smaller system.

1.3. Assuming these are small sized systems, then there is a relationship between small size and a higher capability level for Provide Skilled Human Resources. The projects assessed all had highly skilled resources through a mature training and employment process. This could not have had an influence on the size of the projects. Small projects could have increased the skills in the department by creating opportunities on a larger number of diverse projects.

1.4. Relationship between determining the functional size pre- and post-development and a lower software engineering infrastructure provision capability level. This does not seem to have a reason.

3.2.10 Hypotheses

1.1. None

3.2.11 Summary

1.1. No obvious correlation between functional size and Organisation processes, although a smaller sized system may have a higher business re-engineering and process definition capability level.

3.3 Footprint <-> Capability Level of OU

For the purposes of comparison, instead of using values for the footprint, the indicators high(H), medium(M) and low(L) will be used where high indicates that the graph is high above baseline, medium is close to baseline and low is below baseline. There is a certain amount of inadequacy with this method, since it is a comparison against the average in the PEP database (baseline). However, it is better than using the figures provided by PEP, since this provides no comparison or idea of whether it is a good or bad number at all. Comparison against the baseline would indicate whether within the scope of the database (which is international) it is good.

The capability level is taken as the highest percentage.

									Capability Level %		
Project	**FDI**	**SI**	**fp/sm**	**fp/m**	**TQI**	**MTTF**	**sc**	**bc**	**0**	**1**	**2**
A	H	M	H	H	M	M	H	L	**51.72**	44.79	3.49
B	H	M	M	M	-	M	-	-	27.59	**72.41**	0
C	H	M	H	H	H	H	H	M	27.59	**72.41**	0
D	H	M	H	H	H	M	H	M	27.59	**72.41**	0

									Capability Level %		
Project	FDI	SI	fp/sm	fp/m	TQI	MTTF	sc	bc	0	1	2
A	21.6	8.6	60	101	9.2	1.0	-7%	58%	**51.72**	44.79	3.49
B	14.7	8.3	18	50	-	8.5	-	-	27.59	**72.41**	0
C	20.6	10.1	25	62	14.7	22.0	0%	25%	27.59	**72.41**	0
D	20.9	9.3	38	78	12.1	11.0	-53%	25%	27.59	**72.41**	0

3.3.1 Possibilities:

1.1. relationship between TQI and capability level of organisation unit. Possibly an organisational unit with a higher capability level has a higher amount of information recorded for testing and early operation and greater controls on the quality of the product. This will need to be confirmed at the process level i.e. Manage Quality, Perform Work Product Verification, Perform Work Product Validation, Integrate and Test Software, Integrate and Test System. This seems to indicate a relationship between error tracking and capability. Examining ISO/IEC 15504-5, it is seen that for the first time at capability level 2, *Problem report and corrective actions database* is an infrastructure characteristic.

1.2. ignoring project B, relationship between budget conformance and capability level of organisation unit. Possibly an organisational unit with a higher capability level has a higher amount of control over the cost. This will need to be confirmed at the process level i.e. Manage Project. Another point to remember is that Project A was a fixed cost project, while Projects C and D were time and material. In other words, projects C and D would never really run over budget.

3.3.2 Hypotheses

1.1. At a higher capability level, the function delivery rate would increase, and the processes which would be required to achieve the higher capability level would be at a constant, which would mean that cost (and therefore budget) would decrease and schedule would be met, making the footprint appear high above baseline in three spokes.. This is not necessarily true, since you can decrease cost, schedule and budget, but sacrifice other performance indicators such as technical quality index. From the above, although the capability levels are different, all four projects have a fairly high function delivery index. Indications are that as one moves up the capability maturity scale, productivity would increase, costs would decrease, estimations would improve and quality would increase.

1.2. Once the relationship between the footprint performance indicators is stabilised, it may then b possible to "stretch the rubber band" evenly across all performance indicators. This may relate directly to an organisation's capability level i.e. the achievement of a managed process by moving from capability level 1 to 2.

3.4 Footprint <-> Capability Level Of Process

									Customer-Supplier				
Project	FDI	SI	fp/ sm	fp/ m	TQ I	MT TF	sc	bc	1	2	3	4	5
A	H	M	H	H	M	M	H	L	-	1	2	-	1
B	H	M	M	M	-	M	-	-	-	1	1	1	1
C	H	M	H	H	H	H	H	M	-	1	1	1	1
D	H	M	H	H	H	M	H	M	-	1	1	1	1

									Customer-Supplier				
Project	FDI	SI	fp/ sm	fp/ m	TQ I	MT TF	sc	bc	1	2	3	4	5
A	21.6	8.6	60	101	9.2	1.0	-7%	58%	-	1	2	-	1
B	14.7	8.3	18	50	-	8.5	-	-	-	1	1	1	1
C	20.6	10.1	25	62	14.7	22.0	0%	25%	-	1	1	1	1
D	20.9	9.3	38	78	12.1	11.0	-53%	25%	-	1	1	1	1

3.4.1 Possibilities:

1.1. relationship between FDI and Manage Customer Needs process. There does not appear to be a reason why there would be any relationship, however a strong customer relationship could improve the gathering and controlling of requirements changes, and then also the project functional size, thereby improving the FDI.

1.2. relationship between FDI and Provide Customer Servi process. There does not appear to be a reason why there wc be any relationship, however a strong customer relationship could improve the support, training and establishment of customer satisfaction, and then also the project functional size, thereby improving the FDI.

1.3. relationship between staffing index and Manage Customer Needs process. There does not appear to be a reason why there would be any relationship, however a strong customer relationship could improve the gathering and controlling of requirements changes, and thus also communication and require an average number people to be involved in the project, making the staffing index average

1.4. relationship between staffing index and Provide Customer Service process. There does not appear to be a reason why there would be any relationship, however a strong customer relationship could improve support, training and establishment of customer satisfaction, and thus also communication and require an average number people to be involved in the project, making the staffing index average.

1.5. inverse relationship between technical quality index and Supply Software process. There does not appear to be a reason why this relationship would be inverse. A packaging, delivery and installation process should have been assisted by a good testing process which would have resulted in the high number of errors detected during testing and early operation.

1.6. inverse relationship between budget conformance and Supply Software process. There does not appear to be a reason for this relationship. Packaging, delivery and installation process should have no influence on the planned vs. the actual budget.

3.4.2 Hypotheses

1.1. having Customer-Supplier processes at a higher capability level would improve the technical quality index and decrease MTTF, thereby making the footprint appear better.

									Engineering						
Project	FDI	SI	fp/sm	fp/m	TQI	MTTF	sc	bc	1	2	3	4	5	6	7
A	H	M	H	H	M	M	H	L	1	1	1	1	1	1	-
B	H	M	M	M	-	M	-	-	1	1	1	1	1	1	-
C	H	M	H	H	H	H	H	M	1	1	1	1	1	1	1
D	H	M	H	H	H	M	H	M	1	1	1	1	1	1	1

									Engineering						
Project	FDI	SI	fp/sm	fp/m	TQI	MTTF	sc	bc	1	2	3	4	5	6	7
A	21.6	8.6	60	101	9.2	1.0	-7%	58%	1	1	1	1	1	1	-
B	14.7	8.3	18	50	-	8.5	-	-	1	1	1	1	1	1	-
C	20.6	10.1	25	62	14.7	22.0	0%	25%	1	1	1	1	1	1	1
D	20.9	9.3	38	78	12.1	11.0	-53%	25%	1	1	1	1	1	i	1

3.4.3 Possibilities:

1.1. relationship between FDI and all Engineering processes, except Maintain System and Software. It could be argued that following basic software engineering practices would have a positive effect on your project size, time and effort and thus on your FDI.

1.2. relationship between SI and all Engineering processes, except Maintain System and Software. There does not appear to be a reason why there would be any relationship, however good software engineering practices could indicate team are fairly experienced, and thus require an average number people to be involved in the project, making the staffing index average.

3.4.4 Hypotheses

1.1. having Develop System Requirements and Design, Develop Software Requirements, Integrate and Test Software and Integrate and Test System processes at a higher capability level would improve the technical quality index and decrease MTTF, thereby making the footprint appear better, since the checks required by the V-model would be fully institutionalised.

									Support							
Project	FDI	SI	fp/sm	fp/m	TQI	MTTF	sc	bc	1	2	3	4	5	6	7	8
A	H	M	H	H	M	M	H	L	0	0	0	0	1	1	0	1
B	H	M	M	M	-	M	-	-	1	1	0	1	1	1	1	1
C	H	M	H	H	H	H	H	M	0	0	0	1	1	1	0	1
D	H	M	H	H	H	M	H	M	0	0	0	1	1	1	0	1

									Support							
Project	FDI	SI	fp/sm	fp/m	TQI	MTTF	sc	bc	1	2	3	4	5	6	7	8
A	21.6	8.6	60	101	9.2	1.0	7%	58%	0	0	0	0	1	1	0	1
B	14.7	8.3	18	50	-	8.5	-	-	1	1	0	1	1	1	1	1
C	20.6	10.1	25	62	14.7	22.0	0%	25%	0	0	0	1	1	1	0	1
D	20.9	9.3	38	78	12.1	11.0	-53%	25%	0	0	0	1	1	1	0	1

3.4.5 Possibilities:

1.1. inverse relationship between FDI and Perform Quality Assurance process. It could be argued that minimising these practices would decrease the amount of "administration", and therefore also the time and effort to produce a system of that size, thereby increasing FDI, since the projects are fairly small. However, the future negative effects cannot be assessed.

1.2. relationship between FDI and Perform Work Product Validation, Perform Joint Reviews and Perform Problem Resolution processes. A strong customer relationship could improve the gathering and controlling of requirements changes, and then also the project functional size, thereby improving the FDI.

1.3. relationship between SI and Perform Quality Assurance process. It could be argued that minimising these practices would decrease the amount of "administration", and therefore also the time and effort to produce a system of that size, thereby ensuring that an average size team is not required, since the projects are fairly small. However, the future negative effects cannot be assessed.

1.4. relationship between SI and Perform Work Product Validation, Perform Joint Reviews and Perform Problem Resolution processes. A strong customer relationship could improve the gathering and controlling of requirements changes, and thus also communication and require an average number people to be involved in the project, making the staffing index average.

1.5. inverse relationship between fp/sm and Develop Documentation, Perform Configuration Management and Perform Audits processes. It could be argued that minimising these practices would decrease the amount of "administration", and therefore also the time and effort to produce a system of that size, thereby increasing functionality delivered per staff month, since the projects are fairly small. However, the future negative effects cannot be assessed.

1.6. inverse relationship between fp/m and Develop Documentation, Perform Configuration Management and Perform Audits processes. It could be argued that minimising these practices would decrease the amount of "administration", and therefore increasing functionality delivered per month, , since the projects are fairly small. However, the future negative effects cannot be assessed.

1.7. relationship between TQI and Perform Work Product Verification process. Usage of formalised testing process would mean a larger number of records kept, accounting for the unavailability of TQI for project B. Also, the higher the capability level of the process, the greater the number of errors detected during testing and early operation. Strangely, the same does not appear to be true for Perform Work Product Validation - this may be a result of it being partially controlled by the user in some cases, who may not have contributed to the metrics captured for PEP.

1.8. inverse relationship between schedule conformance and Develop Documentation, Perform Configuration Management and Perform Audits processesIt could be argued that minimising these practices would decrease the amount of "administration", and therefore also the time and effort to produce a system of that size, thereby increasing schedul. conformance, since the projects are fairly small. However, the future negative effects cannot be assessed.

1.9. relationship between schedule conformance and Perform Work Product Validation, Perform Joint Reviews and Perform Problem Resolution processes. A strong customer relationship could improve the gathering and controlling of requirements changes, and then also the project functional size, thereby improving the schedule conformance.

1.10. relationship between budget conformance and Perform Work Product Verification process. A possible explanation may be that verification would minimise rework, which would allow the project to meet it's schedule and therefore it's estimated cost.

3.4.6 Hypotheses

1.1. having Support processes at a higher capability level would improve the technical quality index and decrease MTTF, thereby making the footprint appear better.

Project	FDI	SI	fp/ sm	fp/ m	TQ I	MT TF	sc	bc	Management 1	2	3	4
A	H	M	H	H	M	M	H	L	1	0	0	-
B	H	M	M	M	-	M	-	-	1	0	1	-
C	H	M	H	H	H	H	H	M	1	1	0	-
D	H	M	H	H	H	M	H	M	1	1	0	-

Project	FDI	SI	fp/ sm	fp/ m	TQ I	MT TF	sc	bc	Management 1	2	3	4
A	21. 6	8.6	60	101	9.2	1.0	7%	58 %	1	0	0	-
B	14. 7	8.3	18	50	-	8.5	-	-	1	0	1	-
C	20. 6	10. 1	25	62	14. 7	22. 0	0%	25 %	1	1	0	-
D	20. 9	9.3	38	78	12. 1	11. 0	- 53 %	25 %	1	1	0	-

3.4.7 Possibilities:

1.1. relationship between FDI and Manage the Project process. Having a higher capability level for project management could have a positive influence on project time and effort, and thus on FDI.

1.2. relationship between SI and Manage the Project process. An average team size may be easier to manage as a result of there being less communication overhead, but still a reasonable amount of resources to complete work, increasing the capability level of managing the project.

1.3. inverse relationship between fp/sm and Manage Risks process. More risk management mechanisms could decrease the number of function points delivered per staff month.

1.4. inverse relationship between fp/m and Manage Risks process. More risk management mechanisms could decrease the number of function points delivered per month.

1.5. relationship between TQI and Manage Quality process. Usage of formalised testing process would mean a larger number of records kept, accounting for the unavailability of TQI for project B. Also, the higher the capability level of the process, the greater the number of errors detected during testing and early operation.

1.6. relationship between schedule conformance and Manage the Project process. Having a higher capability level for project management could have a positive influence on project time and effort, and thus on schedule conformance. The fact that project B has no schedule conformance measure places some doubt on this comparison.

1.7. inverse relationship between schedule conformance and Manage Risks process. More risk management mechanisms could decrease the number of function points delivered per staff month and thus the on-time delivery.

1.8. relationship between budget conformance and Manage Quality process. Having a low capability level for quality management could have a negative influence on project time and effort, as a result of the amount of rework required, and thus on budget conformance. The fact that project B has no budget conformance measure places some doubt on this comparison.

3.4.8 Hypotheses

1.1. None.

									Organisation				
Project	**FDI**	**SI**	**fp/ sm**	**fp/ m**	**TQ I**	**MT TF**	**sc**	**bc**	**1**	**2**	**3**	**4**	**5**
A	H	M	H	H	M	M	H	L	0	0	0	1	0
B	H	M	M	M	-	M	-	-	0	0	0	1	1
C	H	M	H	H	H	H	H	M	1	1	0	1	1
D	H	M	H	H	H	M	H	M	1	1	0	1	1

									Organisation				
Project	**FDI**	**SI**	**fp/ sm**	**fp/ m**	**TQ I**	**MT TF**	**sc**	**bc**	**1**	**2**	**3**	**4**	**5**
A	21.6	8.6	60	101	9.2	1.0	7%	58%	0	0	0	1	0
B	14.7	8.3	18	50	-	8.5	-	-	0	0	0	1	1
C	20.6	10.1	25	62	14.7	22.0	0%	25%	1	1	0	1	1
D	20.9	9.3	38	78	12.1	11.0	-53%	25%	1	1	0	1	1

3.4.9 Possibilities:

1.1. inverse relationship between FDI and Improve the Process process. Having a higher FDI would mean that each project would not necessarily contribute lessons learned or suggestions for process improvement. Introducing changes to an environment will require a learning curve, which will initially decrease productivity.

1.2. relationship between FDI and Provide Skilled Human Resources process. Having a well-defined HR process would mean that project teams would be fairly easily resourced correctly with as experienced team members as possible, thereby reducing any overhead of unskilled people, and increasing the speed of the project and decreasing effort, thereby increasing FDI.

1.3. relationship between SI and Improve the Process process. Introducing changes to an environment will require a learning curve and may require additional resources, which will initially decrease productivity.

1.4. relationship between SI and Provide Skilled Human Resources process. Having a well-defined HR process would mean that project teams would be fairly easily resourced with a reasonable amount of resources for the project with as experienced team members as possible, resulting in an average SI.

1.5. relationship between TQI and Engineer the Business, Define the Process, Provide Software Engineering Infrastructure processes. Usage of formalised testing process would mean a larger number of records kept, accounting for the unavailability of TQI for project B. Process definition and SE infrastructure may have resulted in the availability of the process, allowing for a greater number of errors to be detected during testing and early operation. A reason for therelationship between Engineer the Business and TQI may be that an organisation engineers the business to fulfil their business goals and with a goal such as improving quality, one would be improving the technical quality if better testing and reviews were taking place.

1.6. inverse relationship between schedule conformance and Improve the Process process. Since each project would not necessarily contribute lessons learned or suggestions for process improvement, this would reduce the project time, and improve schedule conformance. The long term effect of this cannot be assessed. Introducing changes to an environment will require a learning curve, which will initially decrease productivity and impact negatively on schedule.

1.7. relationship between schedule conformance and Provide Skilled Human Resources process. Having a well-defined HR process would mean that project teams would be fairly easily resourced correctly with as experienced team members as possible, thereby reducing any overhead of unskilled people, and increasing the speed of the project and decreasing effort, thereby increasing schedule conformance.

1.8. relationship between budget conformance and Engineer the Business, Define the Process and Provide Software Engineering Infrastructure processes. If the business meets it's goals, has a defined process and software engineering infrastructure, it should be more likely that it would be able to meet it's budget.

3.4.10 Hypotheses

1.1. None

3.5 Limitations Of SPICE Covered By PEP

1.1. SPICE looks at qualitative measures i.e. capability levels and gives an idea of why things are happening to processes in 'operational' terms.

1.2. PEP may be the equivalent process measures for the following:

PEP	SPICE
Function delivery index	Manage the project
Staffing index	Provide Skilled Human Resources
Function points/staff month	Manage the project
Function points/month	Manage the project
Technical quality index	Manage Customer Needs Integrate and Test Software Integrate and Test System
Mean time to failure	Manage Customer Needs Integrate and Test Software Integrate and Test System
Budget conformance	Manage the project
Schedule conformance	Manage the project

1.1. PEP displays a limited number of measures, which should be standard project measures, recorded as outputs of a normal software engineering project management process.

1.2. CSC analyses the data and returns a report provided by Quantimetrics. The action workshop is facilitated by Quantimetrics, and although workshop participants mention a large variety of action points, there are too many to actually follow up. Although an external consultant is independent, they do not have the insight into the internal OU workings which are known, but not 'documented'.

1.3. Currently, no organisations provide international SPICE benchmarking and in order to provide this, a standard assessment input will be required.

3.6 Limitations Of PEP Covered By SPICE

1.1. PEP looks at quantitative measures i.e. cost, quality, effort and gives an idea of what is happening to processes in business terms.

1.2. PEP factors people and technology into some of the measures. SPICE limits this influence to Level 1 (Performed) i.e. if an organisational unit does not have reasonably skilled resources on these technologies, they will not perform the base practices, and a process would not assist them anyway. This means, in PEP it is difficult to isolate the influence of the process alone.

1.3. No indication by PEP of whether product quality is predictable and consistent. At such a low capability level, performance is very much dependent on human (including environment) and technological factors.

1.4. The influence of rework is not factored into PEP. Rework would have a negative influence on all.

1.5. PEP appears to ask the person's opinion, which is probably 90% true, but there is no validation with anyone else that that specific comment is true and this is in effect limited to what the person knows eg. how does a person know that CM will be beneficial? Would they ever put as their comment that we did not have sufficient documentation, if they realise that by making a comment like that they will probably need to ultimately document their code, design and analysis? The qualified assessor analyses the SPICE assessment profiles, and can list the processes requiring improvement, as well as providing recommendations (as an internal resource, who is part of the process).

1.6. Strengths of the process were highlighted more within SPICE than within PEP.

1.7. Although PEP records are completed by the project leader, since these are often outdated and based on memory, they are not always able to be QA'ed. For SPICE, the qualified assessor is required to validate all ratings and cross check with output work products. Also, since process performance is very much a habit, resources will usually remember how they performed a process.

1.8. SPICE is an international standard type 2 technical report, and many other process improvement techniques are already making accommodation to incorporate SPICE into their current models.

1.9. Each process in SPICE should have an independent process measure, and if the SPICE benchmarking project gets off the ground, as well as ownership, an OU will be able to compare internationally on a standard level (i.e. using the same process input). The fact that PEP process measures cross boundaries makes it difficult to distinguish which software engineering process is influencing the results.

1.10. Internal qualified assessors can be trained and assessments can be done at any time, not according to external time constraints. These internal assessors will have insight into both the SPICE standard and the OU processes, thereby being able to do more accurate process analysis and re-engineering, and being able to quickly see whether changing a process will improve anything significantly.

3.7 Limitations Of Both PEP And SPICE

1.1. For a Level 0 or 1 organisation unit, it seems to be fairly difficult to decide where to start with process improvement. OU goals are often broader, and not specifically focused on a process (and should not be). The word 'quality' is over-used and to say a goal is to improve quality is like saying you want to make more money - there are so many ways to start. With most process improvement initiatives, difficulties have been quoted as being management commitment and culture change. This seems to be the case with PEP and SPICE too, however SPICE provides a process improvement process, which if controlled as a project may result in continual improvements. PEP too has an action workshop following the results, and if the proposed actions are prioritised and put together as a project, they could result in improvements.

1.2. There is no detail on which processes influence others. or which footprint performance indicators influence each other. However, methodologies such as CMM and Trillium provide roadmaps or key process areas as guidance on the order in which processes may be improved.

1.3. During the assessments, the one measure, from the SPICE work product 'Measures', which was not a formal work product was Quality measures. Quality measures are an important part of measurement and do not replace process measures.

1.4. Data analysis seems to be missing from within the organisational unit, but is considered of greater importance than the data collection itself.

1.5. Improvement should include researchers, practitioners and customers.

1.6. Separate assessments within PEP and SPICE may be required as a result of the different methods used by the different groups within IT Application Systems (also a characteristic of a Level 1 organisation).

1.7. One problem is 'you can't measure chaos'. Measurement would lead to inconsistent results, since they are based purely on individual performance.

1.8. IFPUG's view indicates an intersection between process, project and quality (product) measures. Product quality measures were not included as part of this research, but based on the SPICE assessment, they were often missing from requirements definition. This may be an indication that a fundamental metric is not being formally considered within the current processes.

3.8 Similarities Of Both PEP And SPICE

1.1. The process is very similar i.e. data collection using a tool and resources with required skills.

1.2. According to the guidance provided in ISO/IEC 15504-7, PEP could be seen as fulfilling the role of the Industry norms and benchmarks, with a SPICE assessment falling into the process assessment request.

1.3. Internal qualified SPICE assessors can be trained and assessments can be done as required. PEP baselining can be done ad hoc, provided the external consultant is available.

1.4. Partnering of the techniques may necessitate the following:

1.4.1. PEP providing the facility to factor out the benchmarking results according to software process capability maturity to enable comparison within league or level. PEP evaluates the outputs from the software process, using indices which reflect capability in terms of the time and effort expended to produce a given piece of software.

1.4.2. alignment of the metrics programme with both organisational goals and capability level to allow tracking of achievement of goals.

1.4.3. definition of a number of facilitating base practices for measurement.

1.5. With most process improvement initiatives, difficulties have been quoted as being management commitment and culture change. This seems to be the case with PEP and SPICE too. SPICE provides a process improvement process, which if controlled as a project may result in continual improvements. PEP, too has an action workshop following the results, and if the proposed actions are prioritised and put together as a project, they could result in improvements.

1.6. The time and resource investment is unjustified unless some action takes place as a result of the assessment.

3.9 Summary

1.1. PEP tells you what has happened to your business, SPICE tells you what you could do to improve those measures.

1.2. Diagram p.20 (Garmus & Herron)

Might have a view which has several layers with several measures, but requiring communication well-defined and integrated between all layers/levels to allow for a single vision, direction and allow for measures to influence each other directly

3.10 Communications

1. The l·vel of instability at Level 1 meant that no conclusion within Eskom could be made.
2. Contact had been made with Mary Fisher of BRE' ,.hrough Chris Dale) whose organisation was also Level 1 to 2 with a couple of projects reaching Level 3. She had also been experiencing difficulty in collecting metrics, but they supplied function point counters to assist with data collection and hoped to use it for estimation in the future. They were using Process Professional as their tool. They were going to use a random sample of projects for both PEP and SPICE. She felt they had to organise organisational unit-wide improvement, since most of their projects were small with small teams. PEP was more easily understandable by management and could be used to gen.r.ate support for actions.
3. Debbie Dickson from ABSA said (telephonically) they were in a simila position to Eskom, making use of PEP, experiencing difficulties collecting metrics, and not using SPICE significantly. She believed their organisational unit would also be Level 0-1.
4. Jay van Zyl of Rubico had investigated PEP, but found it inappropriate for their organisation.
5. No response had been received from Risto Nevalainen or Michael Konrad.

3.11 Additional Work

1. Although PEP had included 17 projects and SPICE only 3, SPICE had probably reached the point of diminishing returns, as the assessment results would probably be the same across other projects. During initial data gathering, there had not been any single project among the 17 which had stood out as having information (work products) readily available). Upon review of some of the other reports from PEP, it was decided that there would be no value in reviewing these, since there was so much variation from one to the next. Also, other than the footprint, most of the others were indicators of position in industry, trends and correlation of the entire group of 17 projects. This was probably as result of the lack of Level 2 management practices.

2. Another comparison would be between development and maintenance projects i.e. the long term effect of higher or lower capability level. This would require continued data collection and analysis.

3. Another possibility would be to investigate scaling up (i.e. if a project with a larger function point size of an IT programme and with or without a larger project team), what shape footprint and SPICE profile would it have?