Abstract
This document describes the requirements for, the theory behind and the development of a SPICE-based usability maturity model. The model is a draft version which will be refined and tailored to the particular needs of INUSE clients. The current state of development of the model is assessed. The model itself is contained in a companion document. This document should be read prior to looking at the model.

Keywords: capability maturity models, usability, process improvement, SPICE
INUSE workpackage 5.1 is concerned with the development of a model for the assessment of the maturity of an INUSE client’s software lifecycle. The first activity in this workpackage is the synthesis of existing models of usability maturity into a draft model. This document D5.1.1(t) describes the requirements for, the theory of and the development of the draft usability maturity model D5.1.1. The draft model itself is in a companion document D5.1.1(m) Human-Centred Process Assessment - A Model and Maturity criteria. Together these documents: D5.1.1(t) and D5.1.1(m) comprise INUSE deliverable D5.1.1.

Meetings on the requirements for human-centred process improvement organised or attended by INUSE staff concluded that there is a need for a maturity model for usability processes in the system development lifecycle. Because the resources on the INUSE project are limited, effort will be concentrated on producing a tool which delivers an assessment report of use to the typical INUSE client by the end of the project.

The principle which will be followed in the development and application of the usability maturity model in INUSE is: if usability is an important attribute of the final product, then human-centred processes are an important part of the software lifecycle. Therefore in projects or organisations which develop products which must have a defined level of usability a means of assessing and, where necessary, improving human-centred processes is advised.

The usability maturity model has two separate scales, one for capability (quality) and one for ‘usability’ (human-centredness). It uses SPICE (Software Process Improvement and Capability dEtermination) as a framework and is based on all existing maturity models for human-centred activities available at the start of INUSE workpackage 5.1. This model will be refined through review by an interest group which is a part of the INUSE user group, and through use in assessments by Lloyd’s Register as part of the INUSE service.
Changes

a  First version  J Earthy       All  DEVELOP.DOC & DEVELOP2.DOC & IN511TA.DOC
1  Final version  J Earthy       All  IN511T1.DOC

Approval

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Author:

J V Earthy ....................................................... Date 30/9/96

Project Manager:

J V Earthy ....................................................... Date 30/9/96

Service Manager:

F J Maclennan ................................. Date 30/9/96

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# TABLE OF CONTENTS

## INTRODUCTION

- Background to this document
- Need for Human-Centred Process Improvement
- Review of needs
- Scope of work to produce the draft model
- Users and user requirements for the model

## DESIGNING THE MATURITY MODEL

- Quality Management and Usability
- SPICE as a framework
- Ingredients of the Model

## DEVELOPING THE MODEL

- Procedure for building the model
- The Usability Maturity scale and process attributes
- Assessment

## REVIEW OF PROGRESS

## REFERENCES/BIBLIOGRAPHY
Introduction

Background to this document

INUSE workpackage 5.1 is developing a model for the assessment of the maturity of an INUSE client’s software lifecycle. The first activity in this workpackage is the synthesis of existing models of usability maturity into a draft model. This draft model fulfils three purposes on the project:

1. It is used by Lloyd’s Register in the provision of an assessment service for partners. This allows partners to gain an overview of the maturity of INUSE clients during process improvement.
2. It can be used by project partners as a briefing document on the improvement of usability processes.
3. It identifies usability engineering as a software engineering discipline.

This document D5.1.1(t) describes the requirements for, the theory of and the development of the draft usability maturity model D5.1.1. The draft model itself is in a companion document D5.1.1(m) Human-Centred Process Assessment - A Model and Maturity criteria. Together these documents: D5.1.1(t) and D5.1.1(m) comprise INUSE deliverable D5.1.1. This document should be read before looking at the model. In July 1997 the model will be revised to take account of review comments and feedback from use of the model in the INUSE project. The revised model will be published as INUSE final deliverable D5.1.7, which will be a public document.

The terms used in this document are defined in the introductory sections of D5.1.1(m).

Need for Human-Centred Process Improvement

The industrial use and scope of a maturity model for human centred activities in the software lifecycle were explored in three meetings in 1996: A meeting on human centred process improvement (HCIP) held by LR under the aegis of INUSE on the 29th March 1996; the Ergonomics Society workshop held on 12th April 1996; a meeting by the Safety Regulation Group of the Civil Aviation Authority on 4th June 1996. The conclusions from these meetings were as follows:

- There is a need for a means of assessing human centred processes in system development projects. There are a variety of reasons for this need. They range from political and professional credibility to assurance of subcontractors and suppliers.
- There is a need for a method for the improvement of human centred processes. This method should address:
  - the internal improvement of human factors, especially in the areas of management, staff capability and process definition,
• the interface of human factors to organisations, especially in the definition of the role of human factors, the quality of communication and the selection of beneficial target groups.

• The novelty, political overtones, image and practice of human factors may make it sensitive to organisational location and attitude. This sensitivity requires that human factors is sympathetic to and adapts to organisational, contractual and project requirements.

• As a result a flexible approach to assessment is required, possibly to the extent of having a modular, customisable maturity model. The structure of existing capability models does not accord well with this flexibility and some degree of method development is required.

• The presentations and discussion at the meeting generated a list of issues which can be used to extend the existing partial usability maturity models and ISO 13407 to produce an INUSE maturity model under WP5.1 for use in WP 7 of INUSE.

• Further funding is required to develop a model which fully meets the requirements of the industry.

• A human centred process improvement group should be set up. This should seek affiliation to existing process improvement groups. The attendees and invitees of both the LR and Ergonomics Society meetings, and the INUSE WP5 partners should be put on the mailing list.

Further discussion between INUSE WP5 partners and leading figures in the area (W Hefley of SEI, G Flanagan of IBM and B Sherwood-Jones of BAeSEMA) have refined and analysed these requirements and scope. The heartening discovery as far as INUSE is concerned is that everyone contacted so far considers that a maturity viewpoint is a new and useful way of considering and assessing the human factors contribution to system development and should be investigated further. The existence of a maturity model for human factors also gives it status as a ‘valid’ part of software engineering.

Review of needs

The conclusions from the requirements phase are as follows:

1. A maturity model for human centred activities in the system development lifecycle is a worthwhile development.

2. The requirements of industry are broad and the model should be able to take account of different development environments, organisational requirements and project goals.

3. There is a need for a means of assessing an organisation’s maturity with regard to usability and human-centred issues. This is very much in line with Crosby’s work on organisations and quality.

4. There is a need for a means of assessing the capability and maturity of a human factors department and the work that it does. This is more in line with the principles of ISO 9001.
5. This may be achieved by a modular construction, tailorable sections or a mechanism for custom-building specific modules in a similar manner to the International Safety Review Scheme or, indeed ISO 9000-3.

6. Little specific support is given by the existing capability modules for the features which appear to be required for the technical level of a scheme which addresses usability issues in any detail.

7. Given the limited resource available, Lloyd's Register should use a ‘deep section’ approach for workpackage 5.1, based on the technical areas covered by the INUSE methods.

8. The results of the application of this scheme should be evaluated for use as experimental input to a broader development.

9. There is also a need for a broad overview of an organisation’s maturity with respect to the human centred approach to system development.

10. The broad assessment would be used by the usability champion in an organisation in order to plan strategy.

11. Existing capability modelling frameworks (SPICE, CMM, Trillium) should be used where possible to ease the burden of the development (e.g. audit procedures, description formats).

12. The existing usability maturity models listed in the references section of this document should be examined for appropriateness, reconciled and used in workpackage 5.1.

13. Efforts should be made to secure resources for the development of a more complete HCPI maturity model.

14. The issues of staff capability, integration with other capability models, tailoring/customisation require further investigation.

15. The use of maturity assessment as part of contractor or supplier accreditation is of interest to INUSE and in significant sectors of industry and should be investigated.

16. The cost of assessment should be kept as low as possible.

This document describes how the maturity model produced in WP5 has developed and how the issues listed above have been addressed in the project. The last section review progress towards meeting the requirements listed above.

**Scope of work to produce the draft model**

The development resource for the model and assessment procedure is one person month and the draft model is to be released in September. The scope therefore has to be very restricted. All effort will be concentrated on producing a tool which delivers an assessment report of use to the typical INUSE client by the end of the project.
Users and user requirements for the model

The primary users of the model are typical INUSE customers. These are (telematics) system developers who want to make products more usable by using user centred methods. The secondary users of the model are as follows:

- human factors departments in larger organisations, human factors consultancies, i.e. groups providing a service to second/third parties,
- software departments in large companies, bespoke IT companies developing software for second/third parties,
- purchasing departments,
- generic IT companies.

The model should produce a diagnostic ‘profile’ to support improvement. As far as INUSE is concerned this means that it should do the following:

- it should give broad and thin organisational attitude coverage to gain an overview to advise the INUSE client as to how to proceed with HF marketing, and
- it should be deep and detailed around the INUSE methods, or the activities which are supported by INUSE methods in order that an assessment of the maturity of the application of the methods can be obtained.

Customisation for process improvement by individual clients, methods for self-assessment, customisation for different roles in the HF service market are all too complex to tackle in the INUSE project. However, an estimate as to whether these are necessary and achievable will be made at the end of the development of the model in 1997.

Designing the maturity model

Quality Management and Usability

Examination of the existing models for capability maturity show a tendency to change focus as successive levels of maturity are achieved. The change is from issues which can be addressed locally, by an individual or the development team, to issues which require increasing degrees of organisational change. This has concerned Sherwood-Jones at SEMA (pers comm), not least because of its implied threat to management. Why do maturity models do this, what does it mean and what can we do to ameliorate this apparent threat?

Flood (1993) reviews quality management methods from the point of view of management science and concludes that total quality management (of which capability maturity and process improvement are a part) is simply another management technique. This explains the encroachment on organisational management as Quality is fully realised within the organisation. However, most Quality gurus tend to act outside of the discipline of management science and proclaim Quality as an absolute requirement for organisations. This leads to a polarisation of attitudes to Quality. Organisations either take to it completely, or reject its benefits; regarding it as just a necessary evil for certain markets.
Promoters of a Human-centred approach to systems development tend to do the same thing and therefore run the same risk. Brennan, speaking at the HCPI meeting (Earthy, 1996) pointed out that Human Factors (HF) has many attributes of a religion. This leads to a hard-line, humanistic attitude amongst committed HF practitioners which does little to forward the cause of human-centredness in the more business-centred world of IT system engineering. The risk to INUSE is that a hard-line, Usability equals Quality, maturity model will polarise potential clients and also be seen as a challenge to process improvement/Quality community. A less extreme, “soft”, approach which allows integration with other management approaches is likely to be beneficial to HF, to software engineering and ultimately to the usability of software in general.

Management science classifies Quality, Safety, Usability etc as organisational hygiene factors. Simpson, Sheffield Hallam *pers comm* recommends that organisations should use each factor in moderation, guided by the benefit to the organisation. Quality Function Deployment (Zultner, 1993) is a method for tuning the lifecycle to deliver a product with particular attributes. The client or market requirements are analysed and the lifecycle activities which are critical in the supply of the required attribute are given special attention in the development of the product. For example, if correctness of output is important then validation testing is emphasised, if speed of delivery is critical then management processes are highlighted, if usability is important then human-centred activities are highlighted. This approach puts HF in context and gives us a basis for our “soft” model of HF: It is important to be human-centred when usability and/or user well-being, and/or organisational fit are important. Gupta at Philips (panel presentation at SPI’96, *in press*) summarised the issue in the following way: Software Process Improvement is about tackling the problems faced by software development managers. Human-Centred process improvement is about improving the product for its users. Each has its place and both are needed.

The principle which will be followed in the development and application of the usability maturity model in INUSE is a “soft” approach: when usability is an important attribute of the final product human-centred processes are an important part of the software lifecycle. Therefore, in projects or organisations which develop products which must have a defined level of usability a means of assessing and, where necessary, of improving human-centred processes is advised.

In conclusion: Usability is orthogonal to Quality Management (capability) not identical or inimical, to it. Usability can be improved on its own terms. The usability maturity model will develop two separate scales, one for capability (Quality) and one for ‘Usability’ (Human-centredness). The term Usability will be used for the attribute to be improved by use of the model because the term, although not used precisely, has this common meaning in the IT industry.

**SPICE as a framework**

Reasons for choosing the SPICE framework and format as a starting point:

- **Available expertise**, LR was manager of the first phase of the international SPICE trials on behalf of the European Software Institute. Given that INUSE staff are unfamiliar with

\[1\] The term Hygiene Factors is employed here as it has come to be understood from Herzberg’s (1966) early theory on motivation.
capability assessment, access to assessors expert with a particular method will allow the assessors to learn very efficiently,

- **Supporting European work**, SPICE is strongly supported in Europe. Results from INUSE can be fed back into SPICE to improve it to the benefit of the EU,

- **Technical**, SPICE is generally considered to be the most technically correct capability model. To summarise the differences between it and other models, other models have been described as roads towards a particular destination whereas SPICE is a map of the terrain which allows the user to navigate to a particular, chosen, objective,

- **Reporting**, In relation to the previous point, one of the useful features of SPICE is that it generates a capability profile for an organisation rather than a one-figure rating. This allows a more tailored assessment or accreditation which may be useful for the range of ways in which human factors are employed in industry,

- **Generality**, SPICE provides standard reference and assessment models which are applicable to many lifecycles and organisational structures,

- **Standard**, SPICE is a proposed standard for process improvement evaluation based on the software lifecycle processes in ISO 12207. This gives it independence from particular lifecycles. In turn ISO 13407 is intended *inter alia* to supplement ISO 12207 with human-centred processes. Basing a model on SPICE and ISO 13407 anchors it firmly in international standards.

- **Practicality**, The model follows the format of a set of SPICE processes as far as possible, because the SPICE model has scope for incorporating any variant processes which emerge during the process of fitting human-centred processes into the framework.

- **Convenience**, The model was prepared using the SPICE format in order to make it more familiar to SPICE users and in order to save effort in designing yet another document format.

**Ingredients of the Model**

The viewpoints and scope of the models used as a basis for the usability model:

- Parts 2 and 5 of SPICE provided the framework for the model.
- ISO 13407 provided detail for base practices, mainly in the support and engineering categories. It also provided descriptions of work products.
- Brian Sherwood-Jones from SEMA, the INUSE project discussions on the classification of usability methods and the US Usability Professionals Association model for usability activities provided a framework of human-centred processes.
- The British HCI Group contribution to version 3 of the BCS ISM defines tasks and roles of HF staff. The roles were assigned to process categories and the tasks were used to define human-centred base practices, mainly in the customer and engineering categories.
- Brian Sherwood-Jones also defines a set of levels and principles for defining the progress through levels. These were used as the basis of usability maturity levels and the human-centred process attributes.
• The IBM Usability Leadership Maturity model provided detail for many base practices and most of the base practices in the organisation process category. It also provides detailed indicators of usability maturity for processes or process categories.

• Trillium and the HCPI meeting provided usability maturity indicators.

In general the European descriptions of maturity levels are negative and describe what is not done, while the American descriptions are positive and describe what is done or what is ideally achieved. Capability models (CMM and SPICE) are also stated in positive terms. It is only when one reads the level above that one what is missing. The allocation of indicators to the levels defined for the model used the optimistic (US, capability) and pessimistic (European, HCI) statements to set the upper and lower bounds of the proposed usability maturity levels.

The construction of the model tested the models used against each other. The findings so far are as follows:

• need for a supervision process in SPICE Management.
• need for a consultancy category in SPICE (put in Customer-Supplier).
• need for more Organisation in the HCI Group industry structure model.
• need for more Support and Customer-Supplier in IBM.
• Trillium is a serviceable and pragmatic capability model.
• Sherwood-Jones has considerable insight into the issues of usability maturity.
• need to test the insights, especially the value chain issues, from the HCPI meeting before confirming them as process attribute indicators.

Developing the Model

Procedure for building the model

The sequence of actions followed in the production of the usability maturity model were and are to be as follows:

1. Prepare a skeleton document based on Part 5 of the SPICE technical report.
2. Transcribe, label and cut up the existing models.
3. Review each element of the models and allocate them to SPICE processes.
4. Type up the collations and reformat into base practices and supporting notes.
5. Add work products from ISO 13407.
6. Extract the base practice headers to a table and do top-down check for correctness of assignment to processes.
7. Collate all the sets of maturity levels and extract synthesised usability maturity levels.
8. Build a set of process attributes for usability starting from Crosby and Sherwood Jones. Decide on the number of levels.
9. Edit the document and send it for review by technical reviewers from the HCPI group.

10. The Base Practices will be refined through a series of small, focused working meetings with members of the HCPI group. Each meeting will take a particular type of organisation on particular topics to check and extend the model where necessary. The meetings will review SPICE and the usability maturity model and then review base practices from the point of view of the attendees and move them/define them/extend the model as appropriate. New supporting text will be added as notes, or the original text from existing models will be re-introduced.

11. The results will be fed back to the SPICE project as well as to refine the model.

12. The process for refining maturity levels will include presentation at conferences, use in assessments and discussion and elaboration by the HCPI Group and INUSE. Maturity levels and process attributes are more abstract and political than the base practices. They will not become ‘set in stone’ as fast as the human-centred base practices.

The Usability Maturity scale and process attributes

The HCPI meeting (Earthy, 96) indicated that fitness for purpose becomes more important and needs to be added to maturity at assessments of lower levels of granularity. The challenges to be addressed can be stated as follows:

1. What are the differences between Usability Maturity levels? and
2. What generic Process Attributes typify each level?

Regarding item 1, Sherwood Jones ‘95 describes the transitions between his levels. These are phrased in a positive way, as required by SPICE. He also describes a number of generic practices for an organisation, although these may not be appropriate for SPICE-like generic transitions. The section on Quality Management and Usability describes how a Human-Centred organisational development philosophy can usefully be seen as orthogonal to Quality Management (known as capability) improvement.

There are two maturity scales in the model. One for Quality management of Usability and one for the organisation’s attitude to Usability as a separate hygiene factor. The quality management of usability is measured by applying the existing SPICE assessment to the new Human-Centred base practices. The levels of maturity in the models used as a basis for the model were used to defined the usability maturity scale and the process attributes. Crosby is used as a focus for the levels and his summaries prefix each level for reference. The section headings are derived from Sherwood-Jones and his ‘commonly heard sayings’ criteria are the basis for the quotes appended to each level.

The levels and attributes will be challenged in use against the following criteria laid down for Capability by Colin Tully at the HCPI meeting:

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ii E.g. a generic/innovation meeting with BT, Phillips, Nokia; a bespoke, IT department meetings with Nat West, Reuters and Lloyd’s Bank; a consultant one with NOMOS, NPL and HUSAT; a software developer one with Logica, SOGEI and SEMA; a model purity one with Hefley, Kelly and Tully, etc.
“Are there generic levels of maturity which could be tailored to suit different practices (organisational, management, technical), e.g. is a practice deployed across a skill base? across products? is the company learning and improving? can they adapt? are practices reviewed for usability and utility and withdrawn?”

Is this enough for usability? Are there any process attributes broad enough to cover the range of all HC processes? These issues will be addressed during the validation of the model in use and by review.

Assessment

LR will use in-house expertise and tools to assess INUSE client organisations against the model.

The criteria for assessment will be derived from indicators given in the models and other sources. Their validity is as follows:

- IBM, Trillium, NOMOS/NPL all have tried and accepted levels and scope;
- Sherwood-Jones, experience based but untested;
- HCPI, emergent issues without levels, untested but based on a body of opinion;
- LR, new indicators to complete model, untested.

For copyright reasons the indicators and detailed practice descriptions cannot be widely released. Summaries will be added to the final model where necessary.

Review of Progress

How far have the requirements listed above been achieved?

1. A maturity model for human centred activities in the system development lifecycle is a worthwhile development. - a draft is now available.

2. The requirements of industry are broad and the model should be able to take account of different development environments, organisational requirements and project goals. - the current model reflects its origins in large organisations. - The proposed workshops will extend the model for a wider context of use.

3. There is a need for a means of assessing an organisation’s maturity with regard to usability and human-centred issues. This is very much in line with Crosby’s work on organisations and quality. - The model provides a way to do this.

4. There is a need for a means of assessing the capability and maturity of a human factors department and the work that it does. This is more in line with the principles of ISO 9001. - The capability dimension of the model will support such assessment.

5. This may be achieved by a modular construction, tailorble sections or a mechanism for custom-building specific modules in a similar manner to the International Safety Review Scheme or, indeed ISO 9000-3. - There will be investigated after the workshops
described as stage 10 in the development process listed in the section of this document (entitled ‘Procedure for building the model’).

6. Little specific support is given by the existing capability modules for the features which appear to be required for the technical level of a scheme which addresses usability issues in any detail. - The work so far indicates that the existing models need extension.

7. Given the limited resource available, Lloyd's Register should use a ‘deep section’ approach for workpackage 5.1, based on the technical areas covered by the INUSE methods. - This did not prove practical.

8. The results of the application of this scheme should be evaluated for use as experimental input to a broader development. - This is outside the scope of the project.

9. There is also a need for a broad overview of an organisation’s maturity with respect to the human centred approach to system development. - The model provides this.

10. The broad assessment would be used by the usability champion in an organisation in order to plan strategy. - It is for this reason that the model will be made as simple as possible.

11. Existing frameworks (SPICE, CMM, Trillium) should be used where possible to ease the burden of the development (e.g. audit procedures, description formats). - This was done.

12. The existing usability maturity models listed above should be examined for appropriateness, reconciled and used in workpackage 5.1. - This was done.

13. Efforts should be made to secure resources for the development of a more complete HCPI maturity model. - Outside scope of INUSE.

14. The issues of staff capability, integration with other capability models, tailoring/customisation require further investigation. - Outside requirements of INUSE.

15. The use of maturity assessment as part of contractor or supplier accreditation is of interest to INUSE and in significant sectors of industry and should be investigated. - To be done.

16. The cost of assessment should be kept as low as possible. - tools are being developed by LR outside of the project to make assessment efficient.
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