ICL - Group Quality

**INTRODUCTION
TO
QUALITY METRICS**
(Issue 2)

INTRODUCTION

It is becoming widely understood that if product quality is not expressed as a set of quantified and measurable objectives, then there is no way of monitoring development progress towards satisfactory completion.

The importance of Quality Metrics has been recognised in ICL, and the following important statements are made in the Group Quality Manual:

> "All systems and services will consistently and without exception meet specified target levels of performance, quality, reliability and safety."

> "All products, systems and services will be engineered to meet targeted measurable quality levels. Quality targets will be set using two basic principles: Fitness for customer use, and minimising total product life-cycle costs."

> "For every product, system and service, marketing must clearly state measurable quality attributes necessary to achieve the Business Case. Quality attributes should be reviewed and approved before development or OEM commitments are made."

> "Every product, system and service should have a product specification containing numerically specified levels for the quality attributes which reflect Marketing Requirements."

> "Throughout the life-cycle of products, systems and services, for the defined critical quality attributes, actual and predicted measurements will be regularly taken to provide an up-to-date picture of quality achievement and improvement tasks to be undertaken."

> "Each Business Centre, Operation or Project Group should have Quality Metrics in place for every product, system or service at the start of the design phase and at every major milestone throughout the product's life. These measures should also be applicable to the activities of subcontractors or vendors who are major contributors to the product."

Without Metrics the first exposure usually encountered by software is the alpha test stage. Using quality targets in conjunctions with Fagan Inspection techniques the resolution of problems at the alpha and subsequent test stages will be easier to clarify and there will be less of them.

OBJECTIVES

The purpose of this booklet is to show the requirements on systems project teams to use Quality Metrics and to follow up the Group Quality message of Management By Objectives.

This purpose must take three phases:

1)   Introduce some software Quality Metrics concepts which ICL should be using   in   all product design.

2)   Expose employees to a quantitative way of thinking about software
        quality; ensuring that some will make these metrics a habit.

3)   Stimulate thinking related to metricating other services within ICL   which can be defined and measured as the process or service is   offered.

This booklet does not attempt to provide detailed quality requirements for every specific product: This work (which is not trivial) should be done by the supplying unit in conjunction with the receiving unit.

This booklet exposes a relatively new subject which needs to be addressed to all services and software provided by ICL.

Why do we need Metrics?

The straightforward way in which Quality Metrics, once developed, can be used will ease the management and structural reporting service within the development effort.

The substitution of a 'Quality Metric Report' in place of a Performance and Sizing report to compare achievement against targets (however specified) must be a fundamental step towards a different cultural approach to measuring quality.

Remember, the objectivity for measurement must be clear, easy to monitor against and *not* subjective.

General requirements

The Group Quality Manual states that the Quality Objectives will be measured against the topics listed below. These topics are explained in the following subsections:

*   Availability
*   Reliability
*   Maintainability
*   Portability
*   Extendability
*   Security
*   Usability
*   Performance
*   Integrity

The Group Quality Manual also makes the following statements to the principles and definition of Objectives:

"All products, systems and services shall be engineered to measurable quality
levels for all critical attributes."

"Quality attributes shall be documented in writing at all stages of design and
marketing".

"All quality attributes shall have a numerically specified level and a numerically
specified tolerance (the allowable deviation from that level)."

"Quality attributes shall be testable and demonstrable in practice by our
customers and ourselves."

"We shall never release any product, system or service which does not meet our stated Quality Objectives."

"Our customers have a right to know the quality levels of any product which they consider ordering or have ordered."

"All Company planning work must include a statement of the measurable quality levels associated with the work of those products involved."

"Quality attributes must be consistent with agreed Group Quality levels. Lesser quality must be formally agreed to."

"Quality requirements must be consistent with planned development costs and operational costs for us and our customers."

"In ICL everyone is a responsible partner in building and maintaining planned quality attributes in our system."

"Know the several dimensions of quality and resources which your activity can impact."

"Make them quantifiable and measurable, in terms of where you are now and where you want to be in the future."

"Declare the contributions you will make to the total product or service quality and your required resources."

"Define the contributions you will make to the total product or service quality and your required resources."

"Define the critical success factors (the things you will be judged on) and know what constitutes pass or fail at every stage."

The following subsections provide some general explanation of the various Quality Objectives. Note that it is up to the project team and Marketing to define the meaning for a particular product and state what is to be measured and what the target is.

Availability

Provide non-stop user solutions. Measured by percentage available when wanted. Target level is 99.9%.

This can be interpreted as a measure of how much a system is usefully available to perform the work for which it was designed.

Reliability

Provide solutions to defects. Measured by percentage of customers reporting real errors at any point in time. Target is less then 2%.

This can be interpreted as a measure of how often the product does what it is intended to do, as opposed to something else, such as producing a wrong answer or producing nothing. Definitions of reliability will therefore vary according to the definitions of what the product is supposed to do. In general, a product which is not doing what it is supposed to do (an unreliable state) is 'unavailable' for its proper work.

This rather general definition needs to be converted to a more specific form for a particular

product if reliability is one of its key quality attributes. The design, tools used and testing strategy must take this into account; reliability does not occur by chance. A common measure is the number of errors found in the first 12 months and/or the monthly error rate, broken down by incident report priority.

Maintainability

Achieve same day repair service. Measured by average time to correct a fault. Target specific to each product.

This can be interpreted as a measure of how quickly an unreliable product can be brought to a reliable state. In general, this will need to cover not only the repair of the fault but recovery from the effects of the fault, so that the product is again prepared to do its proper work.

Portability

Protect today's investment in portable products and standards measured by the cost of transfer of logic, data or hardware. Target is less than 1% cost of items being moved.

This can be interpreted as a measure of the ease of moving a product (function and data) from one environment to another. To define it, the following points should be considered:

* The size of what is being transported
* The original and target environments
* The means of transport (e.g. hand/automatic conversion)
* Attributes of new product compared to the old (side effects)

This might relate to user's costs or ICL's costs.

Extendability

Provide maximum ease for customer to enhance the performance or reliability of his system to his requirements without degrading the existing product quality attributes. Measured by percentage degradation of any other product quality attribute. Target is less than 5%.

This is a measure of the ease of adding new features and functions to an existing product. The following points should be considered:

* The degree of extension (functions, lines of logic data)
* Cost for the extension in resources invested
* Impact on any critical properties (e.g. performance, security, reliability)

This might relate to user's costs or ICL's costs.

Security

Provide the most effective system security protection in the market segment. Measured by comparative tests on competitive equipment simulating security breaches. Targets set for each specific situation.

This is a measure of the probability of counteracting attacks of a particular type. the types of attack to be considered are:

* Attacks on logic (corruption, stealing, disabling)
* Attacks on data (corruption, stealing, knowledge of eliminating)
* Attacks on paper (documentation, instructions, training)

Usability

Provide the best 'ease of use' characteristics in the industry. Measured by initial training requirements and productivity when trained. Target set specific to each system, e.g. 15 minutes self-taught on all office systems.

This is a measure of how well people are going to be able and motivated to use the product effectively. This can be subdivided into:

* Entry requirements (vision, hearing, manual dexterity)
* Learning requirements
* Handling requirements (expressed for different classes of entry level)
* Likeability requirements (how much people like it)

Performance

Best performance in target market segments. Measured on accepted performance criteria. Target is 10% better than competition.

Integrity

This is a measure of the trustworthiness of the product; Is it in the state it is supposed to be in, or has it been altered by persons or by accident, or is it being tapped for information which is now less secret? A product which does not have its full intended integrity may be available in the technical sense, but the intended results may not be available.

Setting detailed Objectives

The Group Quality Manual provides the following guidelines to describe the method to be used by individuals when setting the Quality Objectives for the products, systems, services or component parts for which they are responsible.

These are the principles to observe

**1)   All critical quality attributes must be specified
            and controlled throughout the development process**

A critical attribute is one which if it somehow got out of control would threaten the existence of the system. One need only ask if an extreme value of the attribute is dangerous or disruptive and if the answer is yes, then the project *must* make the effort to define and control the attribute.

**2)   All attributes can and must be made measurable
            in practice.**

It is common practice within ICL to set attributes for major projects in vague terms such as 'lowest possible repair time' or 'substantially improved maintainabilities'. It is possible to interpret this level of language in as many different ways as there are people who will read it. The result is, within ICL, those attributes which are specified so vaguely will lose in the contest for project resources and result in a meeting which will in turn waste valuable management time, cost money, delay the project and deteriorate the quality of the product.

**3)   Attributes should be expressed as a hierarchy of
            sub-attributes**

e.g. Metric   =   *Usable*   =   *Understandable*

e.g. Subs   =   Reliable   =   Concise
                    Accurate   Self-discipline

Complete   Consistent
Consistent

Note: There may be an overlap of sub-attributes, for example, consistency is a sub-attribute of usability and understandability.

There are several reasons for specifying attributes by a hierarchical explosion. It gives an overview when we want it, without disturbing detail. It allows delegation of a long list of attributes of a complex system in an understandable manner. It allows the various Business Centres. Operations and ICL recipients of the product to relate to the attributes which will affect them. It allows the logistical support networks of the company to be tested objectively against a succession of different monitor points. It eventually saves management time. Finally, a hierarchy of attributes allows us to concentrate all our attention on a group of attributes, such as performance (which encompasses more than speed, data throughput and RAM time), with greater ease when we need to.

e.g. Top level = system resilience
     Low level = parity detection

**4)   The language chosen to specify the attributes should
             be understandable to the customers as well as to the
             development specialists**

Remember: All attributes of the system will ultimately be experienced by the customers of the system. They will pay the cost, wait for delivery, wait for corrections and enhancements, learn the operational faults/details and experience (not all) the errors. It is therefore *essential* that all attributes are specified in a language that the customer can understand. Specification *must* always be translated into customer language.

**5)   The attribute specified must be made early in the
             development process and at least before any
             development effort is spent on the design**

In the Cost of Quality Study, ICL is described as a fast-follower in the market place. Because of this, ICL tries to over-react to a design concept or design idea. Clear and complete evaluation of the multiple effects of any proposed technical idea is completely dependent on the clarity and completeness of the attribute specified.

**6)   The level of all other attributes must be
             determined before you can determine the level
             of the last one (or you cannot determine the
             Cost of Quality until you have defined all the
             attributes of quality)**

The practical consequence of this is that if the project has not specified *clearly* one single attribute, e.g. reliability, then ICL cannot realistically determine a major attribute, e.g. development time. It is, of course, possible to fix development time arbitrarily but in doing so the projects have made it impossible to attain the planned levels in other attributes areas.

**7)   A Business Centre cannot really find out the actual
             attributes of a system until it is operational**

It is for this *FACT* that Quality Metrics are essential in a development programme to have clear and precise understanding of what the attributes are planned to be. Early exposure of any product to real work will allow realistic changes to be made.

Specification of Objectives

1)   Identify the five to ten critical measures for success in your area

2)   Specify the measuring idea (e.g. Idea - reliability)

3)   Specify the practical measuring method (e.g. Method = system
        failure rate)

4)   Specify the worst acceptable case for this Objective (e.g. Worst = 4000
        hours)

5)   Specify the planned achievement level (e.g. Plan = 7000 hours)

6)   Specify the point in time to which the worst case and planned level
        apply   (e.g. By = 1.4.85)

7)   Optionally you might like to estimate the best imaginable result, if you were not
constrained by any other Objective, time or money. This gives some perspective as to what
might be achieved if you were given more resources or less constraints in other areas (e.g.
Best = 2000 hours)

8)   You might like to indicate the present or immediate past position for
        these measures, so people can see where you are planning to go (e.g.
        Now = 2000 hours)

9)   Do indicate uncertainty at every opportunity. Don't hide it;
        uncertainty needs attention in the form of deeper analysis and more
        risk-free strategies (e.g. Plan = 7000 + 1000, Best = 10000 to 140000).
        Remember it is not possible to pin down all numbers precisely. The
     planning process needs a formal way to highlight uncertainties and to
     cope with them.

10) Start rough and revise your numbers. Only by identifying relevant
     strategies and estimating their effects can you possibly improve your
     estimated levels for the Objectives.

Example method

Keep to a simple overview:

When you need to expand on one of your major Objectives, keep that detail on a single page.
It is not always easy, but it is always possible. The one-page discipline will encourage you to
keep to essentials.

Make each Objective measurable:

Don't use vague terms like 'substantial performance increase' when you can say '40% net
performance increase by January 1985' or better.

Break complex Objectives down into simpler ones:

For example "usability" might be easier to define, measure and understand if broken down
into beginner level requirement, training time needed, productivity when trained, error rate
when trained, user opinion rating.

Share the Objectives:

 Get formal agreement, by signature, from other team members involved, or from appropriate
colleagues. If there is disagreement regarding Objectives, it is best to bring that problem out

in the open early, and resolve it.

Keep Objectives updated:

Rapidly changing times, competition and technology will make changes to Objectives inevitable. It is easier for all concerned parties to see the difference in old and new Objectives when they are formulated in measurable and quantified ways. Make sure there is a date for each new edition of the Objectives together with a date by which final Objectives will be frozen.

Inspect Objectives:

Conduct formal quality control inspection of Objectives. If you have wrong Objectives, then all your other work to meet them risks being wasted. Check against higher level Objectives and strategies and confirm continuing convergence.

Implementation

Planning

The project team must first identify which are the key quality attributes for a product, probably selected from the list below. These should have been defined by Marketing in the Marketing Requirements Specification:

* Availability
* Reliability
* Maintainability
* Portability
* Extendability
* Security
* Usability
* Performance (this is a key quality attribute)
* Integrity

The project team must then supply quantification for each of the selected key quality attributes, in terms of the items below (as described in the previous sections).   This information should be recorded in the Quality Plan, or in a separate Quality Requirements Specification if the volume is too large.

* Scale of measure
* Test and tracking method.
* Worst acceptable level
* Planned level
* By (date)
* Record, or state-of-the-art level.
* Past accomplishment levels.

These attributes and an outline required achievement level should be specified by Marketing; if they are not, then the project team must define the attributes and levels, and obtain approval from Marketing.

Measuring

At key points in the project life cycle, normally at a design review, before system test, and before each PAC/PRC, measurements should be made (or estimated if measurement is not yet possible) and a report published comparing achievement against requirement and identifying actions to be taken.

Such a Quality Metrics Report must be submitted to the PAC/PRC signatories before signing, and any deviations must be agreed explicitly with Marketing. This report replaces the reports previously required, covering a wider set of quality attributes.

Training

A series of one-day courses will be run by Group Quality using real time analysis from Business Centres currently using Quality Metrics.

Finally

Remember, ICL must maintain its Quality Systems in line with Defence Standard 05-21, which is the basis for ICL's external quality assessment. New procedures/policies/methods must align to the Defence Standard.

and:

Metrics can be used on Metrics. Group Quality can offer assistance to senior management for the monitoring of:

*   Ease of Use
        Prerequisites for using or learning

*   Cost of:
        Development
        Maintenance
        Instruction
        Publication
        Dissemination
        Management involvement
        Making measures

*   Effectiveness
        In getting all employees to use it
        In improving our quality-to-cost ratio