



# What you should know about quality

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## before starting research on quality.

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## Outlines

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### Vol. I

- Introduction
- Quality Factors
- Definitions of Quality Factors
- Definitions of Criteria
- Definitions of Metrics

### Vol. II

- Relationship of Metrics to Quality Factors
- Metric Data Collection

### Vol. III

- Specifying Software Quality
- Measuring Software Quality



## S1-Introduction

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- A major problem is
  - to specify req.s to s.w. developers
  - Determine whether those req.a are being satisfied as the s.w. sys. evolves.
- The desired q. has been defined in **subjective terms**.
- Systems have no **quantifiable** criteria to judge the q. of s.w. until the sys. is under **operational condition**.
- Objective: How to **objectively** specify the desired amount of q. at sys. req.s spec. phase.



## S1-Introduction

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- To quantify s.w. q.:
  1. Determine a set of q. factor.
  2. Determine a hierarchical def. by identifying a set of criteria for each factor.
  3. Define metrics for each criteria and a normalization function.
  4. **Validate metrics** and normalization function by use of case-study.



## S2-Quality Factors

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- Factors: A condition or characteristic which actively contributes to the q. of the s.w.
- **Rules to det. A primary set of q. factors:**
  - A condition or characteristic which contributes to the s.w. q.
  - A user-related characteristic.
  - Relative characteristic b.w. s.w. product.
  - Related to cost and to perform the activity of a function.



## S2-Quality Factors

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- Criteria: att.s of s.w. or s.w. production process. Each factor is judged by one or some criteria.
- **Rules to det. criteria:**
  - Att.s of s.w. or s.w. production process.
  - May form a hierarchical relationship with subcriteria.
  - May effect more than one factor.



## S2-Quality Factors

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- Metrics: Measures of the criteria or sub-criteria related to a q. f..
- Measures may be objective or subjective.
- The units of metrics are chosen as the ratio of actual occurrences to possible number of occurrences.



## S2-Quality Factors

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- A list of terms are extracted from the literature as a base-line or candidate q. f. [table 2.2-2, page 2-5]
- Then rules are applied on them.
- This list contains redundancy or do not comply defined rules.
- So, guidelines are generated to aid grouping factors:





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- This list contains redundancy or do not comply defined rules.
- So, guidelines are generated to aid grouping factors:[table 2.4-1, page 2-7]
  - User-oriented terms: Potential F.
  - S.w.-oriented terms: Potential Cr.
  - Synonyms or logically similar terms are grouped together.



## S3- Definition of Quality Factors

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- Software Product **Activities**:
  - Product operation
  - Product Revision
  - Product transition
- In a **s.w. sys. concerns specify which q. f.** is highly desirable.
- Ex.: experimental sys. with high deg. Of change: flexibility.
- EX.: func.s work long time, but the sys. changes: reusability.



## S3- Definition of Quality Factors

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- A table which shows **where can measure** each q. f..
- A table which shows **where the impact** of not specifying or not measuring each q. f. is effected. [table 3.3-1, page 3-11]



## S4- Definition of Criteria

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- Criteria Purposes:
  - The set of criteria for each f. defines this f.
  - The c. in more than one f. shows the rel. b.w. f.s.
  - The c. allows a one-to-one rel. b.w. metrics and criteria.
  - Establish a hierarchical framework for q. f.s.
  
- A table which shows where can measure each q. f..
- A table which shows where the impact of not specifying or not measuring each q. f. is effected. [table 4.2-1, page 4-7]
- A table which shows the **relationship** b.w. f.s because of **+ or – effect of c.s.** [tables 4.2-2, 4.2-3, pages 4-8, 4-9]



## S5- Definition of Metrics

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- Metrics are defined to provide a measure for criteria.
- **Two types of metrics: Quantity measures, Binary measures.**
- Units of metrics will be chosen as the ratio of actual occurrences to the possible number of occurrences.
- Metrics can be apply at 2 levels: **Sys. Module.**
- A table which shows s.w. q. metrics, the phase and the type.  
[table 6.2-1, page 6-7]



## S6- Relationship of Metrics to Quality Factors

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- The concept of underlying s.w. q. metrics is to use these ctrl vehicles to provide an indication (and a mechanism of ctrl) of the q. of s.w. product to be delivered.
- At any spec. time during s.w. dev., a set of metrics can be applied to available reviews, documents and code.
- **When metrics are applied**, the resulting measurement can be viewed as a **n-tuple:  $(m_1, m_2, \dots, m_n)$** .
- Each  $m_i$  represents a quantitative measure of the sys. with respect to a specific metric or s.w. att..
- Each subset relates to a q. f..



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- Each subset relates to a q. f..
- This could be shown as a function rating a specific q. f.:

$$f(m_1, m_2, \dots, m_n) = r_M$$

$r_M$  is the rating of maintainability of the s.w.

- This is called **a normalization func..**
- As just 2 case-studies data were available, they could not provide validation for q. f.s or normalization functions.



## S6- Relationship of Metrics to Quality Factors

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- It would be most effective if it was on-line to apply metrics. Not after dev. By the use of historical data.
- A regression analysis is performed to derive norm. func.:
- $r_f^p = a_0 + a_1 m_1 + \dots + a_k m_k$   
 $a_i$  are the regression coefficients derived from the regression analysis.
- Several iterations are req. to eliminate the metrics which do not show significant correlation.
- Note: the utility of norm. func. is very dependent upon the sample used.
- The norm. func. can be validate using the variance. Sometimes a none-linear reg. is needed.





## Vol. III- Specifying and measuring s.w. q.

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- As described, determine: q. f.s, criteria, metrics and the norm. func..
- Assume, it is predicted the rating for flex. is 0.33
- And the Acquisition manager specified 0.2.
- The comparison of the predicted rating with specified rating provides a more quantitative indication with an association level of confidence of how well the s.w. dev. is progressing toward achieving the specified levels of quality. Then correction actions would be performed if the predicted rating is lower than the specified rating.



## Resource: Factors in Software Quality

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- RADC-TR77-369, Volume I, Final Technical Report. Jim A. McCall, Paul K. Richard, Genc A. Walters, November 1977
- RADC-TR77-369, Volume II, Final Technical Report. Jim A. McCall, Paul K. Richard, Genc A. Walters, November 1977
- RADC-TR77-369, Volume III, Final Technical Report. Jim A. McCall, Paul K. Richard, Genc A. Walters, November 1977.