8th International Workshop on Software Measurement

September, 18th 1998

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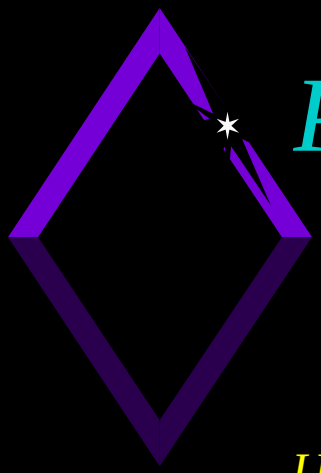

Multidimensional Software Performance Measurement Models: A Tetrahedron-based Design

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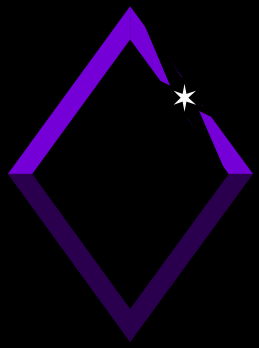
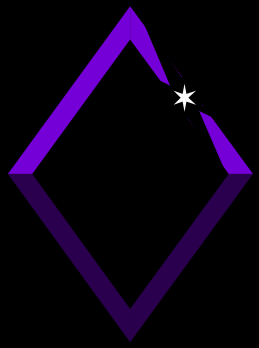


Agenda

- Measurement of performance
- The QEST model
  - Model Structure
  - Geometrical validation
- Implementation procedure: hints
- Conclusions and Next Steps



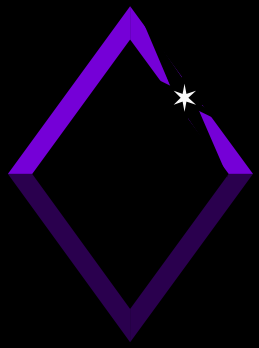
Measurement of Performance

Trend: growing attention towards project measurement, both of process and product, in the Software Engineering community

Practice: many companies have not yet implemented measurement programs

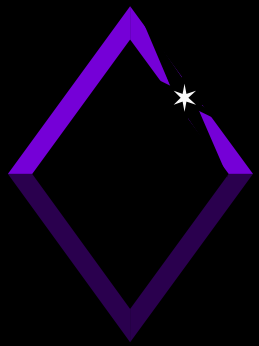
Reasons: I.T. culture and economics

Results: immaturity of processes and products



Measurement of Performance

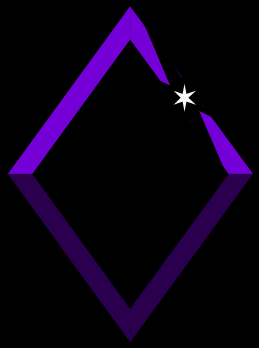
Issue: IT process assessment is expensive and small/medium IT groups believe it is not cost-justifiable, even though there is a process measurement program used by all companies: the *accounting system*



Measurement of performance

Project Performance can be considered as a *multidimensional* concept, given by the concurrent integration of three different viewpoints:

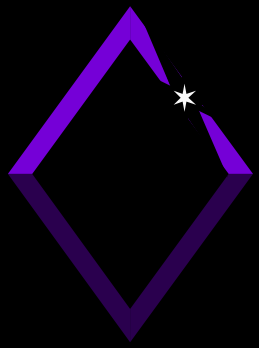
Actors	Viewpoints	Target
Managers	Economic (**E**)	Costs constraint
Users	Social (**S**)	Usability
Developers	Technical (**T**)	Development constraint



Other Studies on Multidimensionality in Software Measurement

Author(s)	Measuring Object	Dimension Concept	Representational Form	Approach Type
Gonzales (1995)	software complexity	Lenght, Time, Level	vectorial (3D)	close
Hatfield (1995)	product performance	asset / customer-project / strategic management	cube (3D)	close
Donaldson & Siegel (1996)	software product/process integrity	single metrics	Kiviat Graphs (2D)	open

In our vision, a *dimension* is a viewpoint and it is preferable to use an *open* approach to performance measurement.



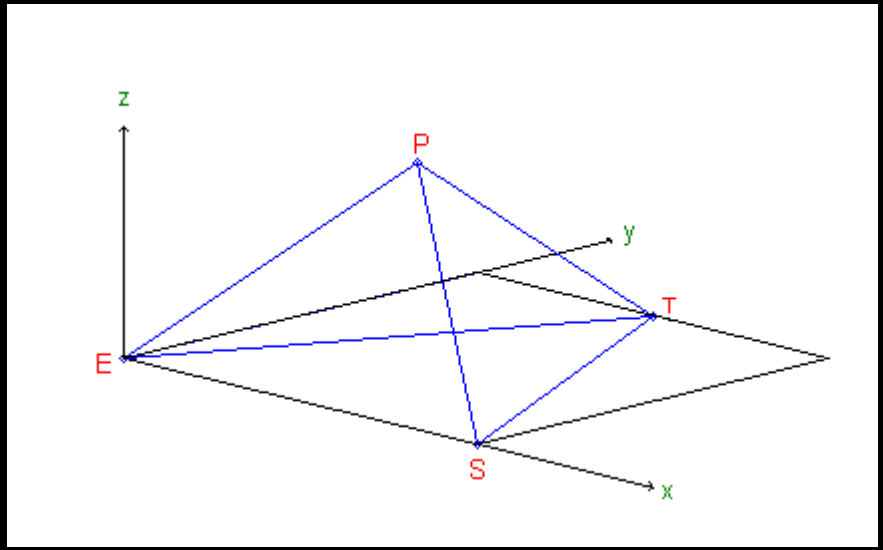
The QEST model

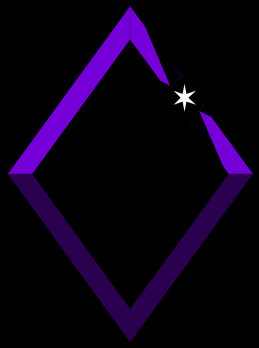
- **Method**: Performance is expressed as the combination of the specific ratios selected for each of the three dimensions of the *quantitative* assessment (Productivity - **PR**) and the perceived product quality level of the *qualitative* assessment (Quality - **Q**)

Performance = PR + Q

The QEST model

- **Model**: **QEST** (**Q**uality factor + **E**conomic, **S**ocial & **T**echnical dimensions) is a "structured shell" to be filled according to management objectives in relation to a specific project.
  Such a model with the ability to handle independent sets of dimensions without predefined ratios and weights sets is referred here as an *open model*





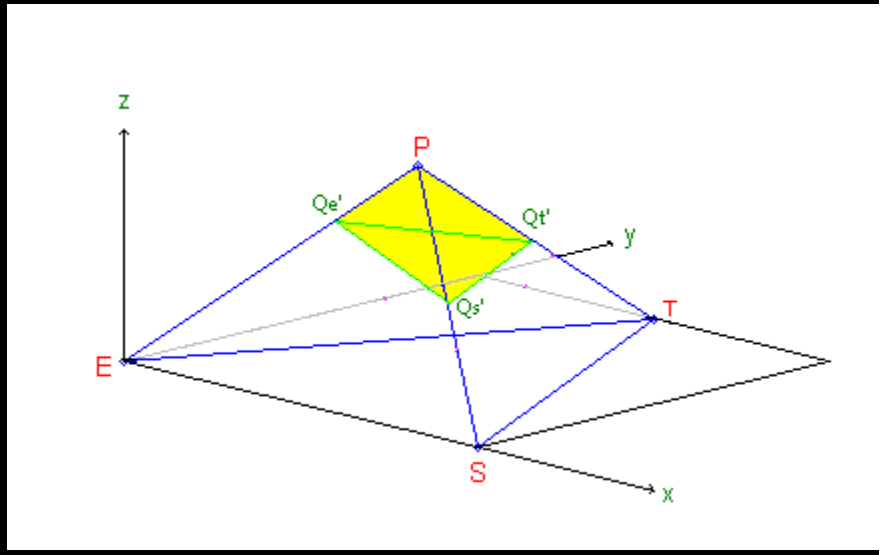
The QEST model

- **Target**: measuring project performance (*p*) using the three distinct viewpoints
- **Input Data**: list of weighted ratios for each dimension and quality questionnaires
- **Output Data**: a unique normalized value

The QEST model - Geometrical validation

It is possible to measure performance considering at least three distinct geometrical concepts:

- the **distance** between the tetrahedron base center of gravity and the center of the plane section along the tetrahedron height – the greater the distance from zero, the higher the performance level;
- the **area** of the sloped plane section – the smaller the area, the higher the performance level;
- the **volume** of the lowest part of the truncated tetrahedron – the greater the volume, the higher the performance level.



The QEST model - Geometrical validation

After (e,s,t) indexes calculation, knowing (E, S, T, p) coordinates:

$$E=(0,0,0);\ S=(1,0,0);\ T=\left(\frac{1}{2},\frac{\sqrt{3}}{2},0\right);\ P=\left(\frac{1}{2},\frac{1}{2\sqrt{3}},\frac{\sqrt{6}}{3}\right);\ H=\left(\frac{1}{2},\frac{1}{2\sqrt{3}},0\right)$$

and that $e'=e+QF$

we calculate the Qe', Qs' and Qt' points:

$$\begin{cases} Qe'=E+e'\bullet\vec{EP}=\left(\frac{1}{2}e',\frac{1}{2\sqrt{3}}e',\frac{\sqrt{6}}{3}e'\right) \\ Qs'=S+s'\bullet\vec{SP}=\left(1-\frac{1}{2}s',\frac{1}{2\sqrt{3}}s',\frac{\sqrt{6}}{3}s'\right) \\ Qt'=T+t'\bullet\vec{TP}=\left(\frac{1}{2},\frac{\sqrt{3}}{2}-\frac{t'}{\sqrt{3}},\frac{\sqrt{6}}{3}t'\right) \end{cases}$$

The QEST model - Geometrical validation

Starting from the generic equation of a plane in a 3D space:

$$\Pi: \begin{vmatrix} X - x_1 & Y - y_1 & Z - z_1 \\ x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ x_3 - x_1 & y_3 - y_1 & z_3 - z_1 \end{vmatrix} = 0$$

the correspondant sloped section equation is:

$$X\frac{(s't'-s'-e't'+e')}{\sqrt{2}}+Y\left(\frac{(s'-2e's'+e'-2t'+s't'+e't')}{\sqrt{6}}\right)+Z\frac{(3-2e'-2s'-2t'+e's'+e't'+s't')}{2\sqrt{3}}+\frac{(e's'+e't'-e'-e's't')}{\sqrt{2}}=0$$

The QEST model - Geometrical validation

Using the coefficients of the sloped section equation:

$$\begin{cases} a = \dfrac{(s't' - s' - e't' + e')}{\sqrt{2}} \\ b = \dfrac{(s' - 2e's' + e' - 2t' + s't' + e't')}{\sqrt{6}} \\ c = \dfrac{(3 - 2e' - 2s' - 2t' + e's' + e't' + s't')}{2\sqrt{3}} \\ d = \dfrac{(e's' + e't' - e' - e's't')}{\sqrt{2}} \end{cases}$$

we derive 4 formulas:

- *exception points* $p = M_x(e', s', t')$ *if e'=s'=1; e'=t'=1; s'=t'=1; e'=s'=t'=1*
- *distance* $p = \dfrac{g}{\sqrt{6}/3}$
- *area* $p = 1 - \dfrac{A}{A_{max}}$
- *volume* $p = 1 - \dfrac{V}{V_{tot}}$

other values

Implementation procedure - *PMAI Cycle*

PLAN

- Selection of representative ratios for the dimensions
- Normalization of the ratios
- Assignment of relative balance between Quantity / Quality project values
- Determi
- Establis

MEASURE

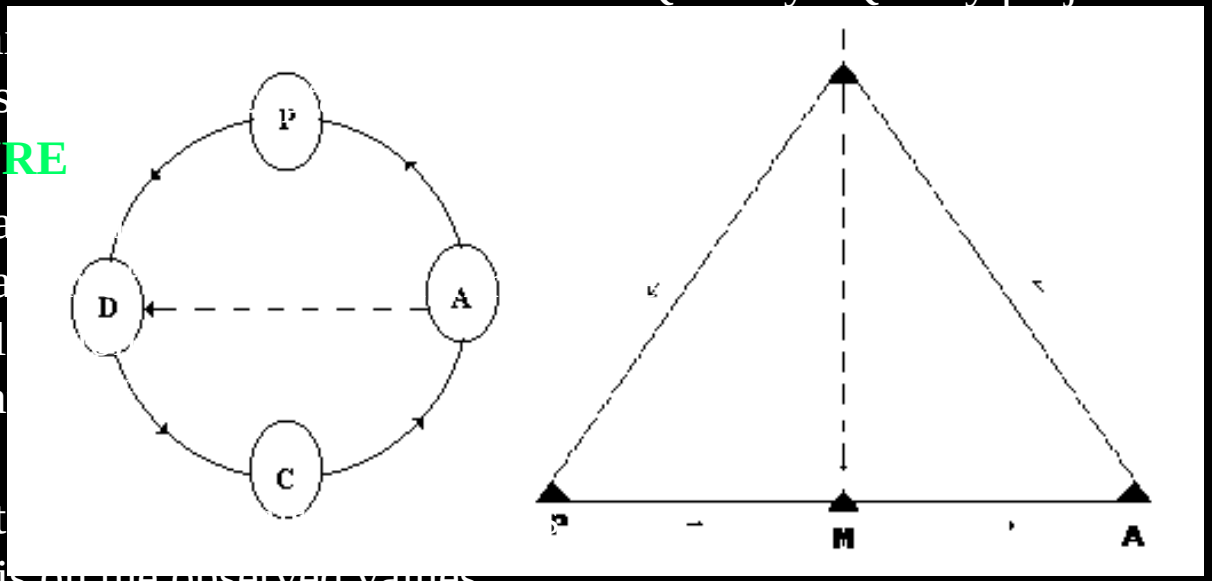
- Data ga
- Applica
- Normal
- Calcula

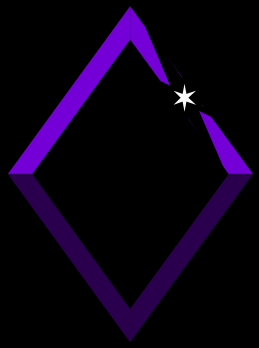
ASSESS

- Present
- Analysis on the observed values

IMPROVE

- Process improvement (based on Process Areas)

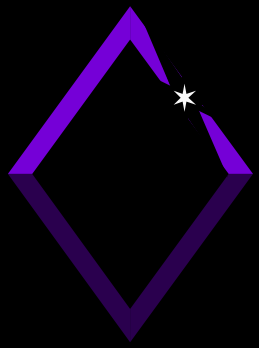




Qualitative assessment

Product Quality is defined as "*the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs*" (ISO 8402)

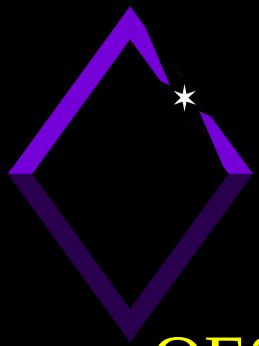
Quality Characteristics are those listed in the ISO/IEC 9126 standard



De facto / de jure Standards

For a greater applicability of the model, it is recommended the use of *de facto*/*de jure* standards as:

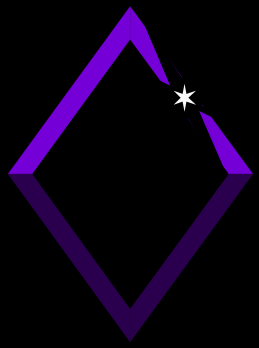
- ISO/IEC 9126 (*for the Social dimension and QF calculation*)
- Function Point Analysis (*for the Economic and Technical dim.*)



Conclusions

- QEST offers a more comprehensive performance measure through a 3D perspective
- We recommends the use of standards as input measures for benchmarking purposes
- Further improvements:
  - a common set of ratios and weights related to the company dimension and typology
  - best ratios number per company dimension (E,S,T)

  witt the aim of *external data comparability* of the results obtained with that method
- It is at a study level the development of a model variant applicable to the Waterfall SLC



Next Steps

- Implementation in industry of version *1.0*:

  Participation to an experimental phase

  would be highly appreciated.

- Improvements to the model itself version *2.0*

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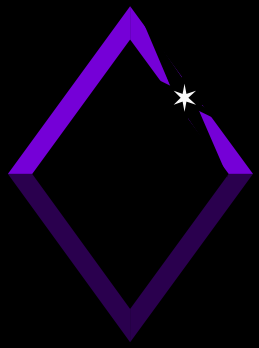

Question Time

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