A Model for Performance Management and Estimation

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Agenda

- **Introduction**
- **Multi-dimensional Performance Models**
  - ✓ QEST-LIME models: description
  - ✓ QEST-LIME models & Performance Estimation
- **An Example with the QEST Model**
  - ✓ Simulation Data (n=10) and R values
  - ✓ Selected Ratios
  - ✓ *p* performance value (with QF)
  - ✓ Possible correlations and suggested regression types
  - ✓ Estimating a new project (P011)
- **Conclusions & Prospects**

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Introduction

- In CMMi, Project Estimation is addressed @ two different levels:
  - Level 2: referring to "*productivity*"
  - Level 4: referring to "*performance*"
- Often people uses these terms interchangeably, while in other sciences (eg: econometrics and management) they are two distinct concepts

Q: What are the main differences between them and their impacts on estimation issues?

Introduction
Productivity-based Estimation (→ML2)

- Productivity: the ratio of the produced output to its corresponding number of inputs (e.g: FP/Man-months)
- Project Estimation is quite challenging, where several techniques can be used: from experiential methods till parametric models
  - **Common point: the usage of productivity figures**
- In most known SPI models, cost estimation is considered as the outcome of the aggregation of several productivity-related process factors, leading to a single cost figure.
- For instance, CMMi, PP SP 1.4-1 (*Determine estimates of effort and costs*): "*Collect the models or historical data that will be used to transform the attributes of the work products and tasks into estimates of the labor hours and cost* " noting that "*Historical data include the cost, effort, and schedule data from previously executed projects, plus appropriate scaling data to account for differing sizes and complexity* ".

Introduction
Performance (→ML4)

- Performance: The degree to which a system or a component accomplishes its designated functions within given constraints (IEEE-STD-610.12:1990)
- Often Software Project Estimation models refer primarily to effort and costs, without taking into account other project attributes (e.g.: quality, innovation, ...).
  - **Note**: performance never cited in CMMi, PP SP 1.4-1
- In CMMi, performance is explicitly included in 2 PAs at ML4 (**OPP** – Org. Process Performance, **QPM**- Quantitative Project Management)

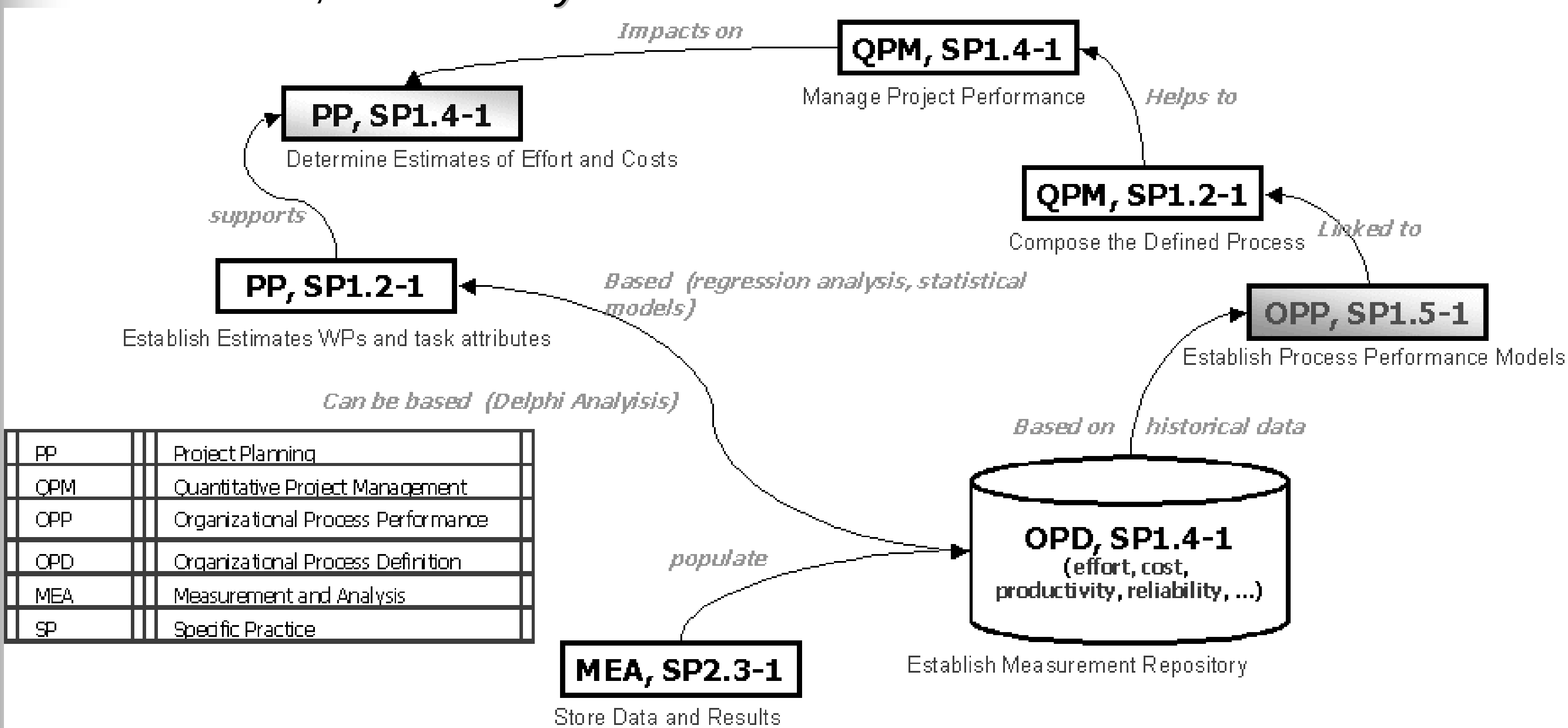
...some questions about OPP:

- what does the CMMi consider as a process performance model (PPM)?
- Which concepts are needed for adequately understanding, managing and estimating performance?
- Is effort & size sufficient to estimate project performance or should further concepts be taken into account?

Introduction
Performance (→ML4)

...and some possible answers from CMMi :

- Performance must be "*used to estimate or predict the value of a process performance measure from the value of other process and product measurements*", using e.g. Complexity and Reliability Growth models
- ...therefore, *Productivity* is an attribute of *Performance*



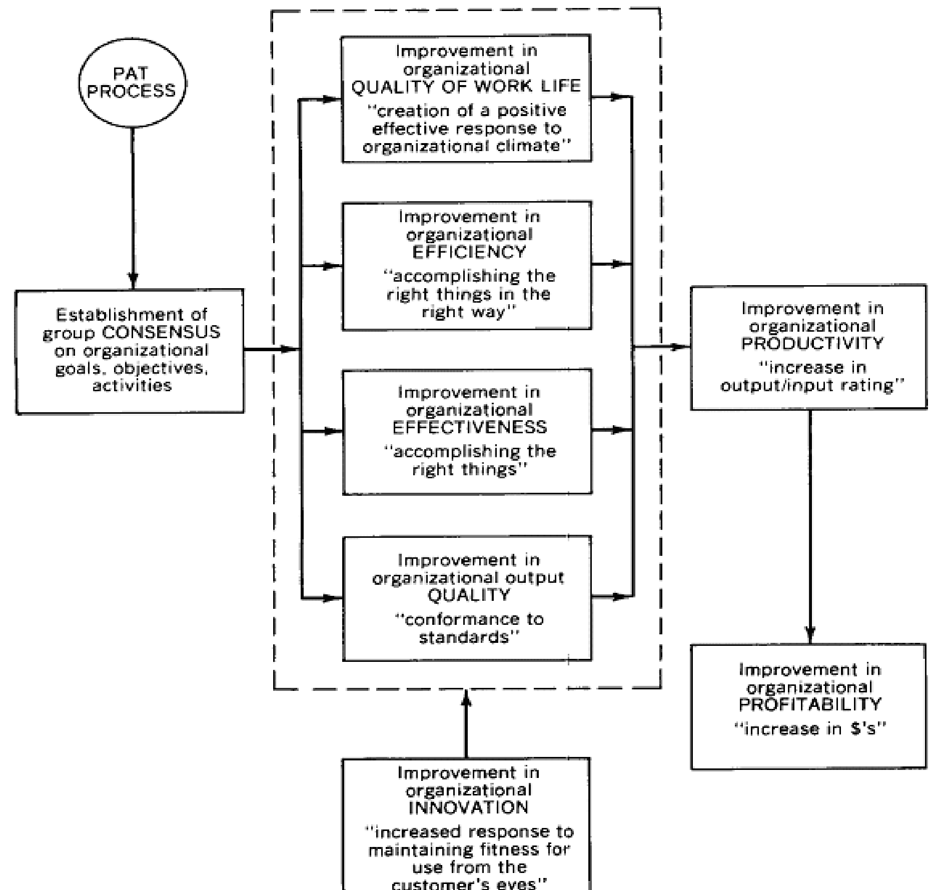
PP	Project Planning
QPM	Quantitative Project Management
OPP	Organizational Process Performance
OPD	Organizational Process Definition
MEA	Measurement and Analysis
SP	Specific Practice

Introduction

Relationships between performance & effort-cost estimation

- In performance models, several ratios can be used to refine overall project estimates
  - e.g.: in the Testing phase, effort based on a relevant % of m/d within the SLC model selected; defect rate and defect density from reliability models, ...

- Sink Model: performance is a multi-perspective concept, where those outcomes impact on productivity
- **Note**: Performance Mgmt and Estimation should be performed considering simultaneously those viewpoints and in a quantitative manner, revisiting estimates along the SDLC phases



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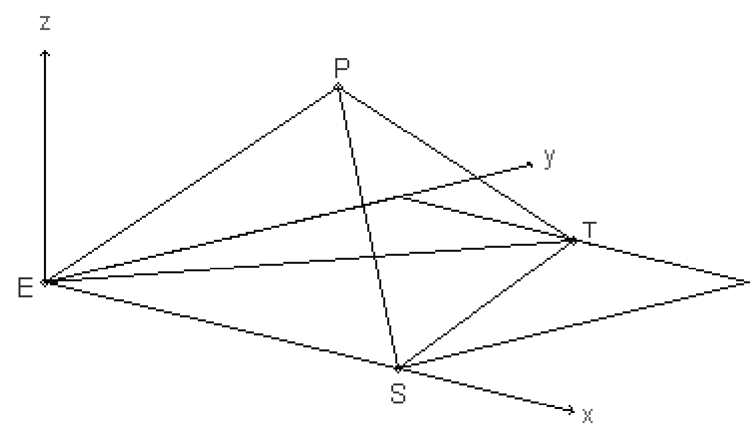
Multi-dimensional Performance Models
The QEST Model

- **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

- **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 has the ability to handle independent sets of dimensions without predefined ratios and weights - referred to as an ***open model***



Multi-dimensional Performance Models
The QEST Model – Geometrical Indicators

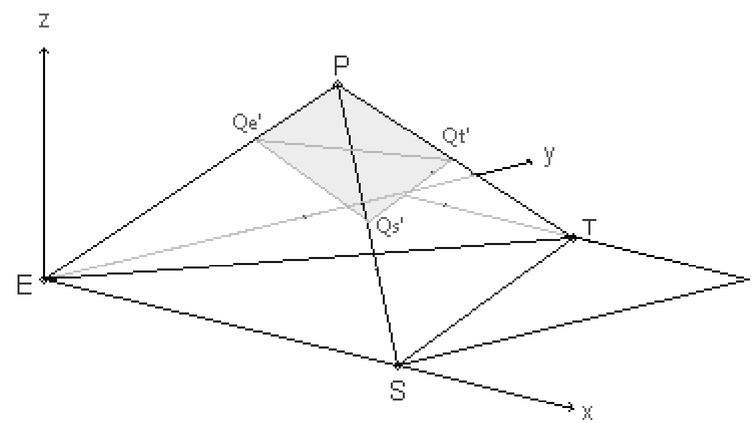
- **Target**: measuring project performance (*p*) using the three distinct viewpoints
- **Input Data**: list of weighted ratios for each dimension and quality questionnaires
- **Output Data**: an integrated normalized value of performance

It is possible to measure performance considering at least 3 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.



Multi-dimensional Performance Models
The QEST Model – Key Features

- Integrated quantitative and qualitative evaluation from three concurrent organisational viewpoints
- a 3D geometrical representation at a single project phase (usually after the project is completed)
- Use of *de facto* and *de jure* standards (e.g. ISO/IEC 9126 for the Quality Factor)
- Extension of the original 3D model to *n* possible dimensions-perspectives → QEST nD through the *simplex* as the mechanism to solve the problem from the fourth dimension on
- Performance Measurement Model to use for consolidating Balanced Scorecard (BSC) measurement outcomes

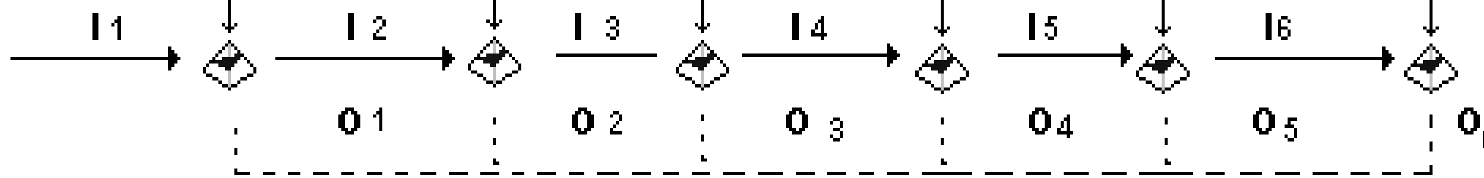
Multi-dimensional Performance Models
The LIME Model

LIME (**LI**fecycle **ME**asurement) model represents the extension of QEST features to a dynamic context as the SLC is.

SLC model selected: generic 6-steps Waterfall model

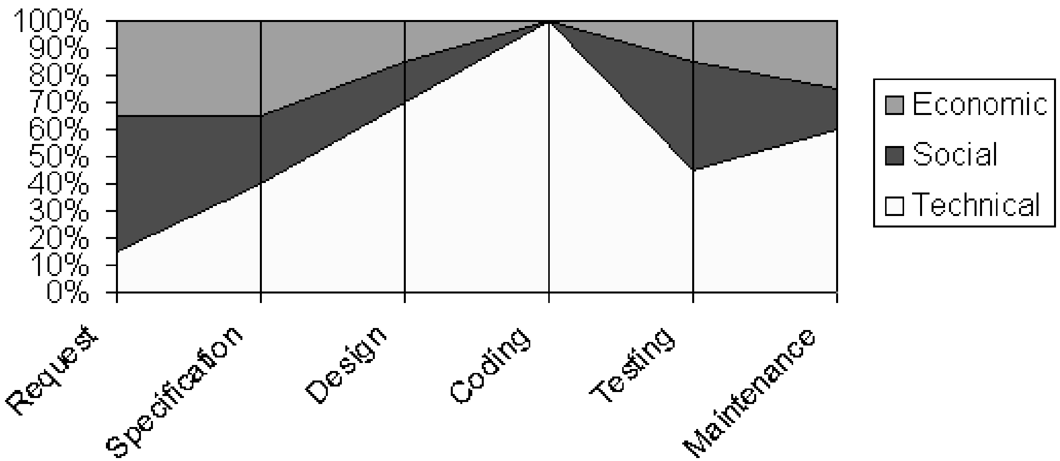
Logic adopted: the same than in the **ETVX** (Entry-Task-Validation-eXit) process notation

Phase	1	2	3	4	5	6
Phase Name	**Requests**	**Specifications**	**Design**	**Coding**	**Testing**	**Maintenance**
% E						
% S						
% T						



Multi-dimensional Performance Models
The LIME Model – Key Features

❶ Flexibility of distinct relative contributions from the three dimensions (E, S, T) in each phase



❷ Flexibility of distinct relative contributions of between quantitative and qualitative evaluations in each phase

❸ Different sources for QF calculation

❹ Flexibility in selecting measures and ratios suitable for each SLC phase

Recently, LIME was extended also to Risk Management → **R-LIME**

Multi-dimensional Performance Models

The QEST/LIME Models & Performance Estimation

- *p* is the performance value coming from QEST/LIME models
  - from QEST → entity: *project*
  - from LIME → entity: *SDLC phase*
- ...and it can be used for estimating next performance:

$$p_i = f\left(x_{1i}, x_{2i}, \ldots, x_{ni}\right)$$ For the i-*th* phase, from n possible ratios

$$p_{i+1} = f\left(p_1, p_2, \ldots, p_i\right)$$ For the (i+1)-*th* phase, from past phases

- Once derived the $p_{(i+1)}$ values, it will be possible to use them for cost estimation (as requested in CMMi PP SP1.4-1)

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An Example with the QEST Model

Simulation Data (n=10) and R values

# m	Project Measures	Definition	Prj value P001	P002	P003	P004	P005	P006	P007	P008	P009	P010
m1	**FFP** - Full Function Points	according to COSMIC-FFP MM2.2	800	260	1050	2900	2800	1350	1950	1600	2500	2850
m2	**WE** - Work Effort (total)	in person/hours (p/h)	550	180	650	1500	1850	650	870	750	1360	1200
m3	**QRC** - Quantity of Reuse Code	in FFPs	100	0	250	300	300	450	200	200	240	140
m4	**QTC** - Quantity of Total Code	in LOC (Java)	22400	7280	29400	81200	78400	37800	54600	44800	70000	79800
m5	**WER** - Work effort for Reuse	in person/hours (p/h)	75	0	55	12,5	90	40	65	55	50	180
m6	**TTT** - Total Training Time	in person/hours (p/h)	30	20	40	60	50	0	16	20	40	28
m7	**EDT** - Esteemed Developed Time	in person/months (p/m)	0,6875	0,225	0,8125	1,875	2,3125	0,8125	1,0875	0,9375	1,7	1,5
m8	**ET** - Elapsed Time (actual)	in person/months (p/m)	3,4375	1,125	4,0625	9,375	11,5625	4,0625	5,4375	4,6875	8,5	7,5
m9	**HDC** - calls to Help Desk	# of calls per unit of time	37	15	40	50	50	42	45	35	48	47
m10	**RTT** - Requested Training Time	in person/hours (p/h)	40	30	48	80	50	20	80	80	60	120
m11	**DD** - Defect Density	# of defects per software component	9	5	18	15	12	16	11	10	14	12
m12	**TE** - Test effort	in person/hours (p/h)	30	23	55	200	155	50	160	100	120	235
m13	**IE** - Inspection effort	in person/hours (p/h)	18	4	15	60	32	16	36	28	72	42
m14	**C90** - Changes during first 90 days after implementation	# of changes	5	10	5	15	12	5	13	8	12	15
	p	QEST performance value	**0,7283**	**0,9400**	**0,7811**	**0,8748**	**0,8867**	**0,9577**	**0,8865**	**0,9805**	**0,8256**	**0,8054**

Project P001

P001	RATIO	NAME	DIM (E, S,T)	Rmin	Rmax	Abs Value	R Value	CMMI v1.1 PAs Involved	SPICE v3.3 PAs Involved
m1/m2	FFP/WE	Project Delivery Rate (PDR)	E	2,0000	6,6670	1,4545	-0,1169	PP SP1.4, PMC SP1.1	MAN.1.4, MAN.1.7, MAN1.10, ORG.5.5
m3/m1	QRC / FFP	% of reused code	E, T	0,0000	0,5000	0,1250	0,2500	PMC SP1.6, TS 2.1	MAN.1.2, ORG.5.8, ORG.5.9
m5/m2	WE / WER	% of WE spent for reuse	E	0,1000	0,5000	0,1364	0,0909	PMC SP1.6	MAN.1.7
m14/m1	C90 / FFP	Stabiility Ratio (SR)	S, T	0,0010	0,0095	0,0063	0,6176	REQM GP2.8	CUS.1.1, CUS.3.2, ENG.2.3
m1/m11	FFP / DD	inverse of Defect Ratio (IDR)	T	1,0000	1000,0000	88,8889	0,0880	VER GP2.8	MAN.2, ORG.1.3
m6/m10	TTT / RTT	Training Time Coverage (TTC)	S	0,0000	1,0000	0,7500	0,7500	OT GP2.8	CUS.5.1, ORG.4.1, ORG.4.3
m1/m8	FFP / ET	Duration Delivery Rate (DDR)	E, T	142,0000	250,0000	232,7273	0,8401	PP SP1.4, PMC SP1.1	MAN.1.10, ORG.5.5
q	Rxy (experience / usability)		S	0,0000	1,0000	0,4000	0,4000	---	CUS.5.4
q	Rxy (education / usability)		S	0,0000	1,0000	0,4300	0,4300	---	CUS.5.4
q	Rxy (age / usability)		S	0,0000	1,0000	0,3000	0,3000	---	CUS.5.4
q	Rxy (ideal / real evaluation)		S	0,0000	1,0000	0,6000	0,6000	---	CUS.5.4

Legend: q=derived from questionnaire

An Example with the QEST Model
Selected Ratios

Quantity Level:	0,75
Quality Level (MQL):	0,25

P001		Weight	R Values	Final Values	Acceptability Threshold	Delta Values
E				**0,2648**	**0,3300**	-0,0652
e1	FFP / WE	0,25	-0,1169	-0,0292	0,1500	-0,1792
e2	QRC / FFP	0,15	0,2500	0,0375	0,0300	0,0075
e3	WE / WER	0,05	0,0909	0,0045	0,0240	-0,0195
e4	FFP/ ET	0,30	0,8401	0,2520	0,1600	0,0920
		0,75				
S				**0,4744**	**0,4200**	0,0544
s1	Rxy (experience / usability)	0,05	0,4000	0,0200	0,0180	0,0020
s2	Rxy (education / usability)	0,02	0,4300	0,0086	0,0085	0,0001
s3	Rxy (age / usability)	0,03	0,3000	0,0090	0,0090	0,0000
s4	Rxy (ideal / real evaluation)	0,25	0,6000	0,1500	0,1750	-0,0250
s5	TTT / RTT	0,30	0,7500	0,2250	0,2300	-0,0050
s6	C90 / FFP	0,10	0,6176	0,0618	0,0400	0,0218
		0,75				
T				**0,2701**	**0,2500**	0,0201
t1	QRC / FFP	0,07	0,2500	0,0175	0,0135	0,0040
t2	C90 / FFP	0,08	0,6176	0,0494	0,0370	0,0124
t3	FFP / DD	0,40	0,0880	0,0352	0,0510	-0,0158
t4	FFP/ ET	0,20	0,8401	0,1680	0,1000	0,0680
		0,75				

An Example with the QEST Model

p performance value (with QF)

_p_ Formula:

$$p = 1 - \prod_{i=1}^{n} \left(1 - p_i\right)$$

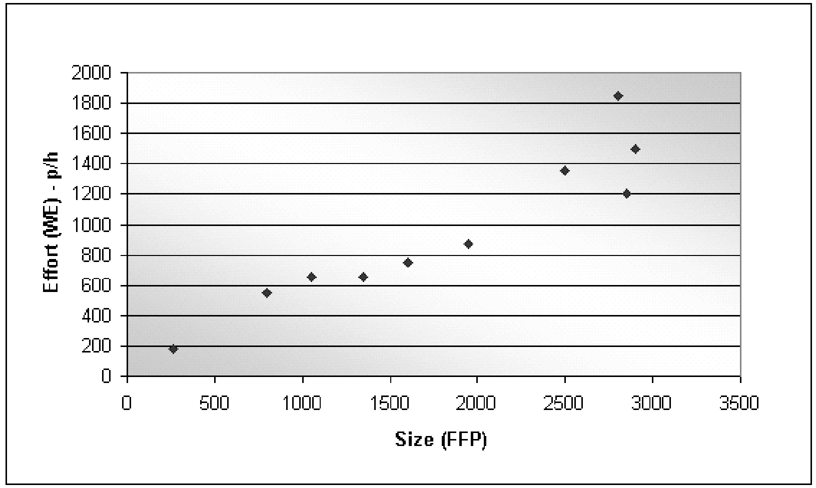
Project P001
(with QF=0.008)

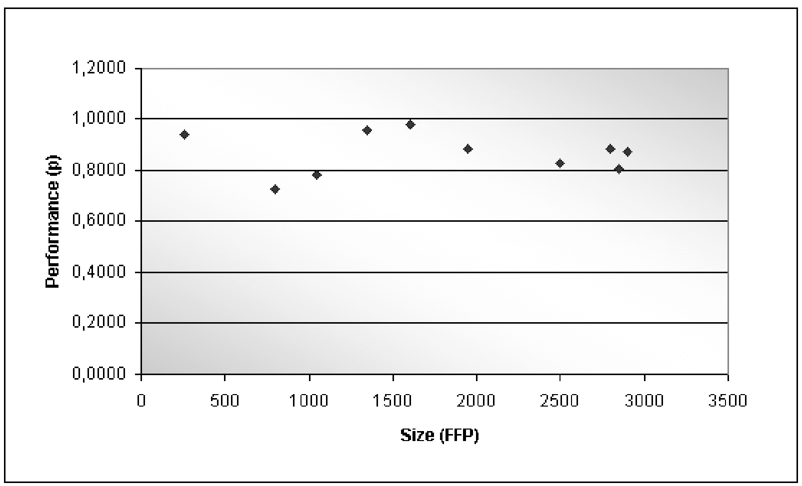
$$P = 1 - \prod_{1=1}^{n+1} (1 - p_i)_i = 1 - (1 - 0.2728)(1 - 0.4824)(1 - 0.2781) =$$

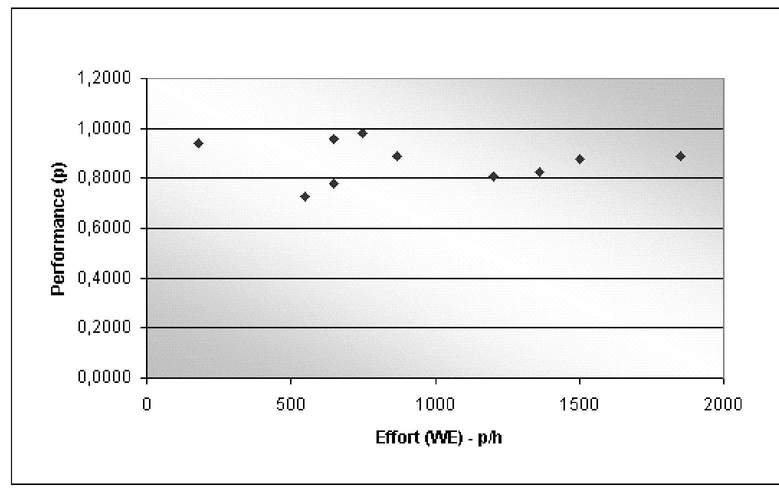
$$1 - (0.7272)(0.5176)(0.7219) = 0.7283$$

					P_e	P_s	P_t				
	e	s	t	QF	(e+QF)	(s+QF)	(t+QF)	$1\text{-}p_e$	$1\text{-}p_s$	$1\text{-}p_t$	p
P001	0,264847	0,474365	0,270116	0,0080	0,2728	0,4824	0,2781	0,7272	0,5176	0,7219	**0,7283**
P002	0,205271	0,825524	0,53802	0,0070	0,2123	0,8325	0,5450	0,7877	0,1675	0,4550	**0,9400**
P003	0,372407	0,481133	0,307365	0,0060	0,3784	0,4871	0,3134	0,6216	0,5129	0,6866	**0,7811**
P004	0,48082	0,428287	0,559978	0,0070	0,4878	0,4353	0,5670	0,5122	0,5647	0,4330	**0,8748**
P005	0,277892	0,52918	0,324436	0,1256	0,4035	0,6548	0,4500	0,5965	0,3452	0,5500	**0,8867**
P006	0,627945	0,254408	0,457918	0,1725	0,8004	0,4269	0,6304	0,1996	0,5731	0,3696	**0,9577**
P007	0,642263	0,328942	0,505639	0,0070	0,6493	0,3359	0,5126	0,3507	0,6641	0,4874	**0,8865**
P008	0,595013	0,373934	0,487947	0,2300	0,8250	0,6039	0,7179	0,1750	0,3961	0,2821	**0,9805**
P009	0,434779	0,478331	0,402004	0,0020	0,4368	0,4803	0,4040	0,5632	0,5197	0,5960	**0,8256**
P010	0,463624	0,35768	0,423395	0,0040	0,4676	0,3617	0,4274	0,5324	0,6383	0,5726	**0,8054**
P011	0,470402	0,729584	0,439165	0,0040	0,4744	0,7336	0,4432	0,5256	0,2664	0,5568	**0,9220**

An Example with the QEST Model
Possible correlations and suggested regression types







An Example with the QEST Model

Possible correlations and suggested regression types

Regression type	Order	Relationship	R^2	Rank	Equation
Linear	1	*Size vs Eff*	**0.8733**	☺	**$y=0.5034x+46.833$**
		Size vs Perf	0.0026	☹	$y=-4E-06x+0.8746$
		Eff vs Perf	0.0098	☹	$y=-2E-05x+0.8818$
Logarithmic	1	*Size vs Eff*	**0.7492**	☺	**$y=579.85Ln(x)-3279.9$**
		Size vs Perf	0.0083	☹	$y=-0.0098Ln(x)+0.9379$
		Eff vs Perf	0.0333	😐	$y=-0.0222Ln(x)+1.0156$
Polynomial	2	*Size vs Eff*	**0.8784**	☺	**$y=5E-05x^2+0.3213x+159,87$**
		Size vs Perf	0.0137	☹	$y=-1E-08^2++4E-05x+0.8481$
		Eff vs Perf	0.0582	☹	$y=7E-08x^2-0.0002x+0.9405$
Polynomial	3	*Size vs Eff*	**0.8809**	☺	**$y=-6E-08x^3-0.0002x^2+0.667x+57.305$**
		Size vs Perf	0.2187	😐	$y=-8E-11x^3+4E-07x^2-0.0005x+0.9985$
		Eff vs Perf	0.0583	☹	$y=-5E-12x^3+8E-08x^2-0.0002x+0.9429$
Polynomial	4	*Size vs Eff*	**0.9062**	☺	**$y=-3E-10x^4+2E-06x^3-0.004x^2+3.5562x-513.2$**
		Size vs Perf	0.7921	😐	$y=2E-13x^4-1E-09x^3+3E-06x^2-0.0027x+1.4329$
		Eff vs Perf	0.1769	☹	$y=8E-13x^4-3E-09x^3+4E-06x^2-0.0022x+1.199$
Polynomial	5	*Size vs Eff*	**0.9149**	☺	**$y=-3E-13x^5+2E-09x^4-6E-06x^3+0.0061x^2-2.0197x+386.39$**
		Size vs Perf	0.8683	😐	$y=-2E-16x^5+1E-12x^4-5E-09x^3+8E-06x^2-0.0053x+1.8528$
		Eff vs Perf	0.6056	☹	$y=-5E-15x^5+2E-11x^4-5E-08x^3+4E-05x^2-0.0155x+2.6399$

- ✓ Three regression types were chosen (linear, logarithmic, polynomial)
- ✓ Smileys show a high-level classification by R^2

An Example with the QEST Model

Possible correlations and suggested regression types

Relationship	Regression type	Order	R^2	Trend	Equation
Size vs Eff	Linear	1	0.8733	---	$y=0.5034x+46.833$
	Logarithmic	1	0.7492	↓	$y=579.85Ln(x)-3279.9$
	Polynomial	2	0.8784	↑	$y=5E-05x^{2}+0.3213x+159.87$
	Polynomial	3	0.8809	↑	$y=-6E-08x^{3}-0.0002x^{2}+0.667x+57.305$
	Polynomial	4	0.9062	↑	$y=-3E-10x^{4}+2E-06x^{3}-0.004x^{2}+3.5562x-513.2$
	Polynomial	5	**0.9149**	↑	$y=-3E-13x^{5}+2E-09x^{4}-6E-06x^{3}+0.0061x^{2}-2.0197x+386.39$
Size vs Perf	Linear	1	0.0026	---	$y=-4E-06x+0.8746$
	Logarithmic	1	0.0083	↑	$y=-0.0098Ln(x)+0.9379$
	Polynomial	2	0.0137	↑	$y=-1E-08^{2}++4E-05x+0.8481$
	Polynomial	3	0.2187	↑	$y=-8E-11x^{3}+4E-07x^{2}-0.0005x+0.9985$
	Polynomial	4	0.7921	↑	$y=2E-13x^{4}-1E-09x^{3}+3E-06x^{2}-0.0027x+1.4329$
	Polynomial	5	**0.8683**	↑	$y=-2E-16x^{5}+1E-12x^{4}-5E-09x^{3}+8E-06x^{2}-0.0053x+1.8528$
Eff vs Perf	Linear	1	0.0098	---	$y=-2E-05x+0.8818$
	Logarithmic	1	0.0333	↑	$y=-0.0222Ln(x)+1.0156$
	Polynomial	2	0.0582	↑	$y=7E-08x^{2}-0.0002x+0.9405$
	Polynomial	3	0.0583	↑	$y=-5E-12x^{3}+8E-08x^{2}-0.0002x+0.9429$
	Polynomial	4	0.1769	↑	$y=8E-13x^{4}-3E-09x^{3}+4E-06x^{2}-0.0022x+1.199$
	Polynomial	5	**0.6056**	↑	$y=-5E-15x^{5}+2E-11x^{4}-5E-08x^{3}+4E-05x^{2}-0.0155x+2.6399$

- ✓ Size vs. Effort: linear and polynomial models (from 2nd order on)
- ✓ Size vs. Performance: polynomial models (from 4th order on)
- ✓ Effort vs. Performance: polynomial models (from 5th order on)

An Example with the QEST Model
Estimating a new project (P011)

Case ❶:

- ✓ <u>Estimated Size</u>: 2500 FP
- ✓ <u>Regression type chosen</u>: Linear (*y*=-4E-06x+0.8746*) [Size vs Perf]
- ✓ <u>p*</u>=0.8646

Case ❷:

- ✓<u>Estimated Size</u>: 2500 FP
- ✓ <u>Regression type chosen</u>: Linear (*y*=0.5034+46.833*) [Size vs Effort]
- ✓ <u>Effort*</u>=1305 man/days

An Example with the QEST Model
Estimating a new project (P011)

Case Ž:

Using the Effort* value (1305 m/d) from project P011 for estimating performance:

✓ Regression type chosen: Linear ($y^* = -2E\text{-}05x + 0.8818$) [Effort vs Perf]

✓ p* = 0.8557

Supposing project P011 has other measures similar to P010:

# m	Project Measures	Definition	P011
m1	**FFP** - Full Function Points	according to COSMIC-FFP MM2.2	2500
m2	**WE** - Work Effort (total)	in person/hours (p/h)	1305,3
m3	**QRC** - Quantity of Reuse Code	in FFPs	120
m4	**QTC** - Quantity of Total Code	in LOC (Java)	70000
m5	**WER** - Work effort for Reuse	in person/hours (p/h)	170
m6	**TTT** - Total Training Time	in person/hours (p/h)	36
m7	**EDT** - Esteemed Developed Time	in person/months (p/m)	1,6317
m8	**ET** - Elapsed Time (actual)	in person/months (p/m)	8,1583
m9	**HDC** - calls to Help Desk	# of calls per unit of time	40
m10	**RTT** - Requested Training Time	in person/hours (p/h)	48
m11	**DD** - Defect Density	# of defects per software component	10
m12	**TE** - Test effort	in person/hours (p/h)	120
m13	**IE** - Inspection effort	in person/hours (p/h)	52
m14	**C90** - Changes during first 90 days after implementation	# of changes	10

An Example with the QEST Model

Estimating a new project (P011)

...from which...

P011	RATIO	NAME	DIM (E, S,T)	Rmin	Rmax	Abs Value	R Value
m1/m2	FFP/WE	Project Delivery Rate (PDR)	E	2,0000	6,6670	1,9152	-0,0182
m3/m1	QRC / FFP	% of reused code	E, T	0,0000	0,5000	0,0480	0,0960
m5/m2	WE / WER	% of WE spent for reuse	E	0,1000	0,5000	0,1302	0,0756
m14/m1	C90 / FFP	Stabiility Ratio (SR)	S, T	0,0010	0,0095	0,0040	0,3529
m1/m11	FFP / DD	inverse of Defect Ratio (IDR)	T	1,0000	1000,0000	250,0000	0,2492
m6/m10	TTT / RTT	Training Time Coverage (TTC)	S	0,0000	1,0000	0,7500	0,7500
m1/m8	FFP / ET	Duration Delivery Rate (DDR)	E, T	142,0000	250,0000	306,4352	1,5225
q	Rxy (experience / usability)		S	0,0000	1,0000	0,3875	0,3875
q	Rxy (education / usability)		S	0,0000	1,0000	0,4200	0,4200
q	Rxy (age / usability)		S	0,0000	1,0000	0,3250	0,3250
q	Rxy (ideal / real evaluation)		S	0,0000	1,0000	0,8000	0,8000

P011		Weight	R Values	Final Values	Acceptability Threshold	Delta Values
E				**0,4704**	**0,3300**	0,1404
e1	FFP / WE	0,25	-0,0182	-0,0045	0,1500	-0,1545
e2	QRC / FFP	0,15	0,0960	0,0144	0,0300	-0,0156
e3	WE / WER	0,05	0,0756	0,0038	0,0240	-0,0202
e4	FFP/ ET	0,30	1,5225	0,4568	0,1600	0,2968
		0,75				
S				**0,7296**	**0,4200**	0,3096
s1	Rxy (experience / usability)	0,05	0,3875	0,0194	0,0180	0,0014
s2	Rxy (education / usability)	0,02	0,4200	0,0084	0,0085	-0,0001
s3	Rxy (age / usability)	0,03	0,3250	0,0098	0,0090	0,0008
s4	Rxy (ideal / real evaluation)	0,25	0,8000	0,2000	0,1750	0,0250
s5	TTT / RTT	0,30	1,5225	0,4568	0,2300	0,2268
s6	C90 / FFP	0,10	0,3529	0,0353	0,0400	-0,0047
		0,75				
T				**0,4392**	**0,2500**	0,1892
t1	QRC / FFP	0,07	0,0960	0,0067	0,0135	-0,0068
t2	C90 / FFP	0,08	0,3529	0,0282	0,0370	-0,0088
t3	FFP / DD	0,40	0,2492	0,0997	0,0510	0,0487
t4	FFP/ ET	0,20	1,5225	0,3045	0,1000	0,2045
		0,75				

...this *p* calculations...

An Example with the QEST Model
Estimating a new project (P011)

...till the final values...

	e	s	t	QF	p_e (e+QF)	p_s (s+QF)	p_t (t+QF)	$1-p_e$	$1-p_s$	$1-p_t$	p
P001	0,264847	0,474365	0,270116	0,0080	0,2728	0,4824	0,2781	0,7272	0,5176	0,7219	**0,7283**
P002	0,205271	0,825524	0,53802	0,0070	0,2123	0,8325	0,5450	0,7877	0,1675	0,4550	**0,9400**
P003	0,372407	0,481133	0,307365	0,0060	0,3784	0,4871	0,3134	0,6216	0,5129	0,6866	**0,7811**
P004	0,48082	0,428287	0,559978	0,0070	0,4878	0,4353	0,5670	0,5122	0,5647	0,4330	**0,8748**
P005	0,277892	0,52918	0,324436	0,1256	0,4035	0,6548	0,4500	0,5965	0,3452	0,5500	**0,8867**
P006	0,627945	0,254408	0,457918	0,1725	0,8004	0,4269	0,6304	0,1996	0,5731	0,3696	**0,9577**
P007	0,642263	0,328942	0,505639	0,0070	0,6493	0,3359	0,5126	0,3507	0,6641	0,4874	**0,8865**
P008	0,595013	0,373934	0,487947	0,2300	0,8250	0,6039	0,7179	0,1750	0,3961	0,2821	**0,9805**
P009	0,434779	0,478331	0,402004	0,0020	0,4368	0,4803	0,4040	0,5632	0,5197	0,5960	**0,8256**
P010	0,463624	0,35768	0,423395	0,0040	0,4676	0,3617	0,4274	0,5324	0,6383	0,5726	**0,8054**
P011	0,470402	0,729584	0,439165	0,0040	0,4744	0,7336	0,4432	0,5256	0,2664	0,5568	**0,9220**

Thus:

- ✓ **Case 1**: (Size vs Perfomance) → **p*** = 0.8646 (1 variable)
- ✓ **Case 2+3**: (Size vs Effort; Effort vs Performance) → **p***=0.8557 (all sys)

QEST performance value	0,9220	
p estimated	0,8646	0,8557
MRE%	6,23%	7,19%

An Example with the QEST Model

Estimating a new project (P011)

Conclusions:

- ✓ considering the two estimated values, the lower MRE is the one obtained using the *size vs performance* equation (6.23% vs 7.19%)
  - ✓ Iterative control using the estimated p, size and effort
- ✓ Using QEST/LIME models it is possible to verify the proper fit of other measures and balance them in order to optimise the amount of resources used and the final project costs, taking care of concurrent constraints
  - ✓ **Advantage**: the use of initial project effort estimation through its size in combination with performance estimation can provide PMs an additional checking tool for controlling project costs

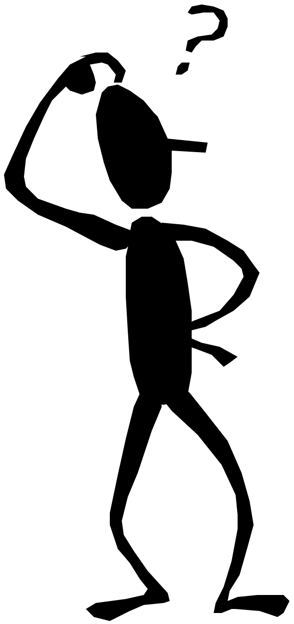
Agenda

- **Introduction**
- **Multi-dimensional Performance Models**
  - ✓ QEST-LIME models: description
  - ✓ QEST-LIME models & Performance Estimation
- **An Example with the QEST Model**
  - ✓ Simulation Data (n=10) and R values
  - ✓ Selected Ratios
  - ✓ *p* performance value (with QF)
  - ✓ Possible correlations and suggested regression types
  - ✓ Estimating a new project (P011)
- **Conclusions & Prospects**

Conclusions & Prospects

- Estimating project costs is one of the key challenges for a Project Manager, firstly in detecting the proper variables to take into account for achieving the minimization of MRE
- Performance plays an important role and current SPI models seems to consider it not explicitly part of the “cost estimation” in Project Planning practices (ML2) but only something to be managed by few people (ML4)
- Estimation requires:
  - the usage of early sizing methods in many cases: it is not possible to define in the bidding phase e.g. FP or UC
  - Integration of multiple viewpoints (project’s stakeholders)
- QEST/LIME represents a family of multi-dimensional software performance models which can help in calculating project performances, providing inputs for a more comprehensive estimation
- When a consistent data collection with QEST/LIME models will be done, comparisons with other estimation models (e.g. COCOMO) – only for the subset of performance related to the “effort” variable – will be made

Q & A



Thank you!

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