R-LIME: improving the Risk dimension in the LIME model

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3rd World Congress for Software Quality

26-30 September 2005, Munich (Germany)

Agenda

- **Introduction**
- **Risk Management models & approaches for software**
- **RBM: the Risk Breakdown Matrix**
  - ✓ WBS + RBS = RBM!
  - ✓ An example with RBM
- **R-LIME: improving the LIME model with RBM**
  - ✓ QEST/LIME models: a description
  - ✓ Performance model extensions
  - ✓ R-LIME: the Risk dimension extension
  - ✓ R-LIME: an example
- **Conclusions & Prospects**

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Introduction
Some definitions & basic concepts

- Risk: *the possibility of suffering loss* (Webster's Dictionary)
- In the Sw Development project viewpoint, risks can be translated also into a reduced product quality to the Customer and increased production costs due to rework, wastes, ... (→ CONQ; PONC)
- *Risk in itself is not bad: risk is essential to progress, and failure is often a key part of learning. But we must learn to balance the possible negative consequences of risk against the potential benefits of its associated opportunity* (R.L. Van Scoy, 1992)
- Risk Management: *the <u>systematic</u> process of identifying, analyzing, and responding to project risk. It includes maximizing the probability and consequences of positive events and minimizing the probability and consequences of adverse events to project objectives* (PMI, 2001)

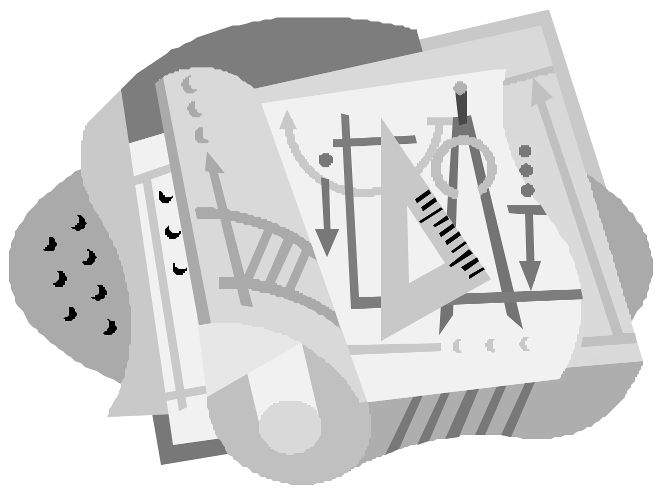
Introduction
Risk Management in SPI models

Maturity Level	Sw-CMM	CMMI
2	· SPP, Ac13 (*identification*) · SPTO, Ac10 (*tracking*)	· PP (*identification and planning*) · PMC (*monitoring*)
3	· ISM, Ac10 (*RM at the organizational level*)	· RSKM (*new PA expanded from the single Ac in ISM*) · DAR (*formal evaluation process to evaluate alternatives for selection and mitigation of identified risks*)
Legend	· SPP = Software Project Planning · SPTO = Software Project Tracking & Oversight · ISM = Integrated Software Management · RM = Requirement Management · Ac = *Activity*	· PP = Project Planning · PMC = Project Monitoring & Control · RSKM = Risk Management · DAR = Decision Analysis & Resolution · PA = *Process Area*

RM processes and practices not fully integrated into PM practices, but managed separately (ref. also a 2004 BCS report): “*regrettably, risk management is often limited to compilation of a risk register at the start of the project which plays little role in the day-to-day management of the project*”

Introduction
Risk Management & Project Management

Q: how to overcome this issue and fully integrate RM outcomes into iterative project re-estimations?



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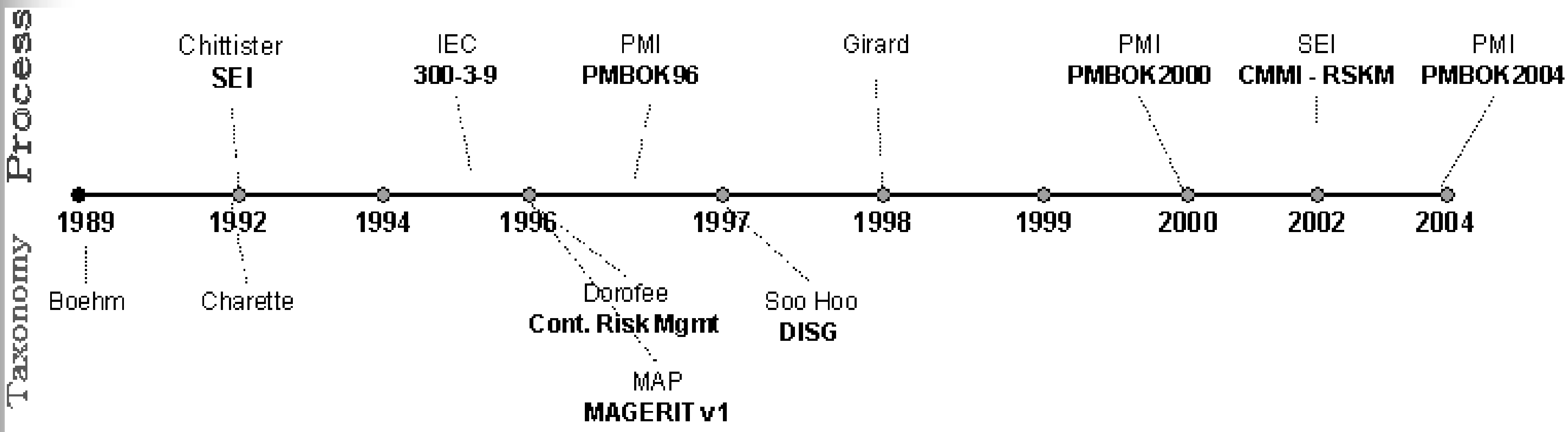
RM models & approaches for software
Some models from the ’90s on



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RBM: the Risk Breakdown Matrix

WBS + RBS = RBM!

- **WBS** (Work Breakdown Structure): it is the functional decomposition of project tasks, defined as "*a deliverable-oriented grouping of project elements that organizes and defines the total work scope of the project. Each descending level represents an increasingly detailed definition of the project work*" (PMI, 2001)
- **RBS** (Risk Breakdown Structure): it is "*a source-oriented grouping of project risks that organizes and defines the total risk exposure of the project. Each descending level represents an increasingly detailed definition of sources of risks to the project* " (D.Hillson, 2003)
  - ✓ Usage of three-four nested levels for detailing risks
  - ✓ Several examples for distinct sectors, including software
  - ✓ Expected to be included as a key concept in the PMBOK2005
- **RBM** (Risk Breakdown Matrix): it is a combination of the two techniques into a single matrix, where:
  - *Rows* represent WBS structure
  - *Columns* represent RBS structure

Source: Grimaldi,S., Rafele C.: *Analisi del Rischio. Modello Gerarchico per l'Analisi del Rischio*, De Qualitate, Ed. Nuovo Studio Tecna (2004). 22-38

RBM: the Risk Breakdown Matrix
WBS + RBS = RBM!

- **Formula:**

$$Rwp_i = \sum_{j=1}^{n} P_{i,j} * M_{i,j}$$

<u>where</u>:

Rwp_i = risk value for the I^{th} Work Package

$P_{i,j}$ = probability of occurrence of the j^{th} risk for the I^{th} Work Package

$M_{i,j}$ = impact due to the j^{th} risk on the I^{th} Work Package

- **Structure:**

			RBS – risky events					Evaluation by WP	
			M1 $p_{i,1}$	M2 $p_{i,2}$	M3 $p_{i,3}$	...	Mn $p_{i,n}$	ΣR	Rank by WP
WBS Work Package	WP1	$I_{1,j}$						$\sum_j R_{1,j}$	
	WP2	$I_{2,j}$						...	
	WP3	$I_{3,j}$		$R_{3,2} = P_{2,3} * M_{3,2}$					
	WP4	$I_{4,j}$							
	WP5	$I_{5,j}$							
	...								
	WPm	$I_{m,j}$							
Evaluation by Risky Events	ΣR		$\sum_i R_{i,1}$	...					
	Rank by Risk type								

RBM: the Risk Breakdown Matrix
WBS + RBS = RBM!

Possible Types of ratings:

- Impact & Probability: both rated in text form within a predefined ranking terminology scale (*ordinal* scale type)
- Impact & Probability: both rated using a numerical scale (*interval* scale type) – **Note**: range used is between 0-10
- Impact rated against a parameter representing each single risky event; Probability as the % of likelihood of occurrence of such event

Nested Levels & Equivalences WBS-RBS

RBM Level	WBS	RBS
0	Project (*root*)	Project risks (*root*)
1	Software Development Phase	Object for risk evaluation
2	Issue within a certain software development phase	Issue within a certain object for risk evaluation
3	Detailed task within the Sub-issue of a certain software development phase	Detailed risk within the Issue of a certain object for risk evaluation

- Peer Levels: definition of a risk pyramid
- Different Levels: deeper analysis on one of the two dimensions

RBM: the Risk Breakdown Matrix
An example with RBM

Hp - Different levels:

- WBS (L1: Project Mgmt; L2: Planning, Meeting & Adm)
- RBS (L1: Program Constraints; L2: Resources; Contract; Prg Interfaces)
- Goal: assessing risk level from main program constraints for the project

		RBS (from Program Constraints)			Evaluation by WP		
	Level 2	**Resources**	**Contract**	**Prg Interfaces**	**ΣR**	**%**	**Rank by WP**
WBS (From Project Mgmt)	**Planning**	R=199	R=109	R=51	**359**	**63%**	**1**
	Meeting	R=35	R=6	R=6	**47**	**8%**	**3**
	Administration	R=48	R=15	R=99	**162**	**29%**	**2**
Evaluation by Risky Events	**ΣR**	**282**	**130**	**156**	**568**	**100%**	
	%	**50%**	**23%**	**27%**	100%		
	Rank by Risk type	**1**	**3**	**2**			

Partial Results:

- ✓ Total Risk Value = 568
- ✓ Planning is the most risky PM activity (63%) – from WBS
- ✓ Resources is the most risky external constraint element (50%) – from RBS
- ✓ Suggestion: analyze RBM L3 for further detailed elements

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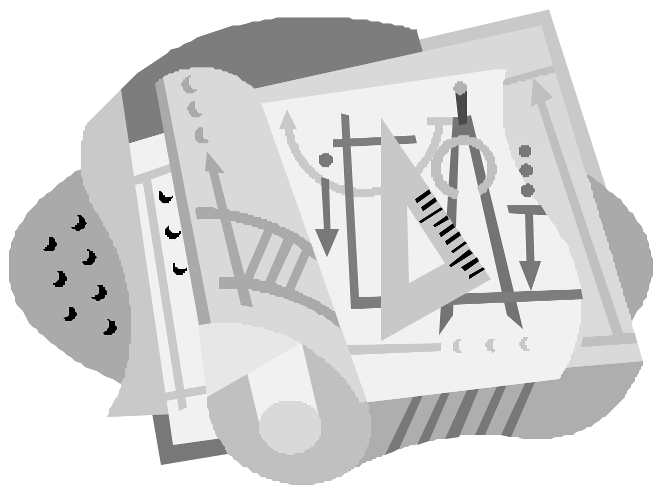
R-LIME: improving the LIME model with RBM
Starting Question

Q: how do we integrate the information from the RBM into the re-planning of the project phase to phase?



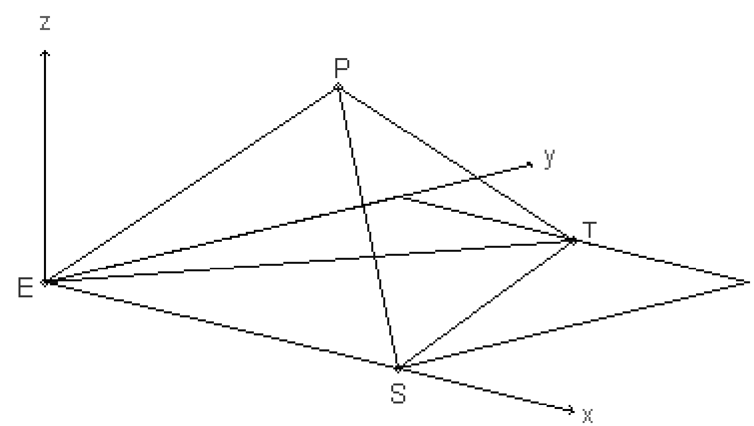
R-LIME: improving the LIME model with RBM
The QEST Model

- **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***



R-LIME: improving the LIME model with RBM

The QEST Model – Geometrical Indicators

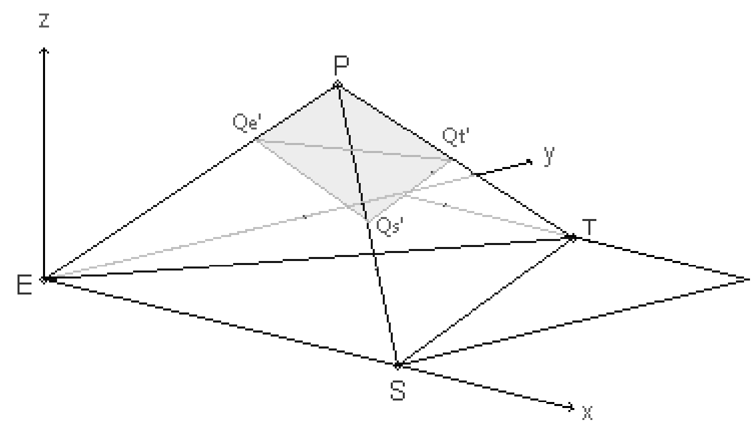
- **Target**: measuring project performance (*p*) using the three distinct viewpoints
- **Input Data**: list of weighted ratios for each dimension and quality questionnaires
- **Output Data**: an integrated normalized value of performance

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.



R-LIME: improving the LIME model with RBM

The QEST Model – Key Features

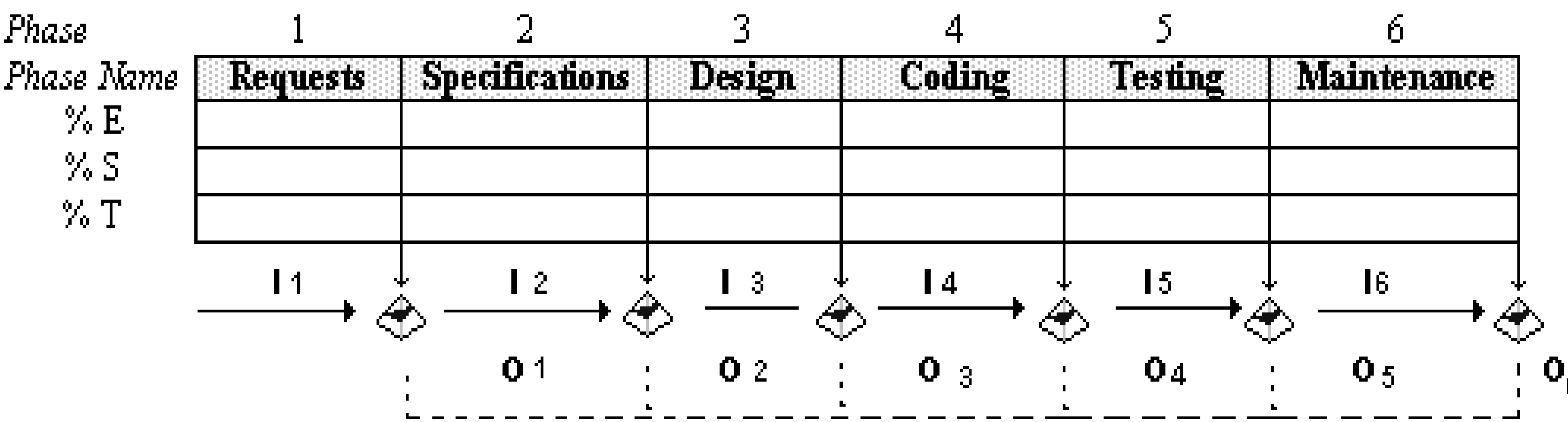
- Integrated quantitative and qualitative evaluation from three concurrent organisational viewpoints
- a 3D geometrical representation at a single project phase (usually after the project is completed)
- Use of *de facto* and *de jure* standards (e.g. ISO/IEC 9126 for the Quality Factor)
- Extension 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

R-LIME: improving the LIME model with RBM
The LIME Model

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

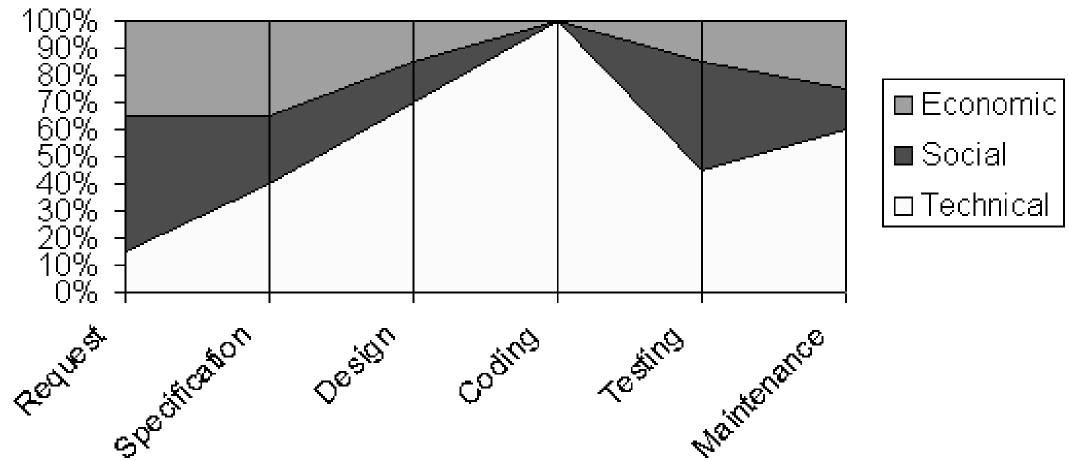
SLC model selected: generic 6-steps Waterfall model

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



R-LIME: improving the LIME model with RBM
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

R-LIME: improving the LIME model with RBM
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)

- Basic Model: LIME nD

R-LIME: improving the LIME model with RBM
R-LIME: the Risk dimension extension

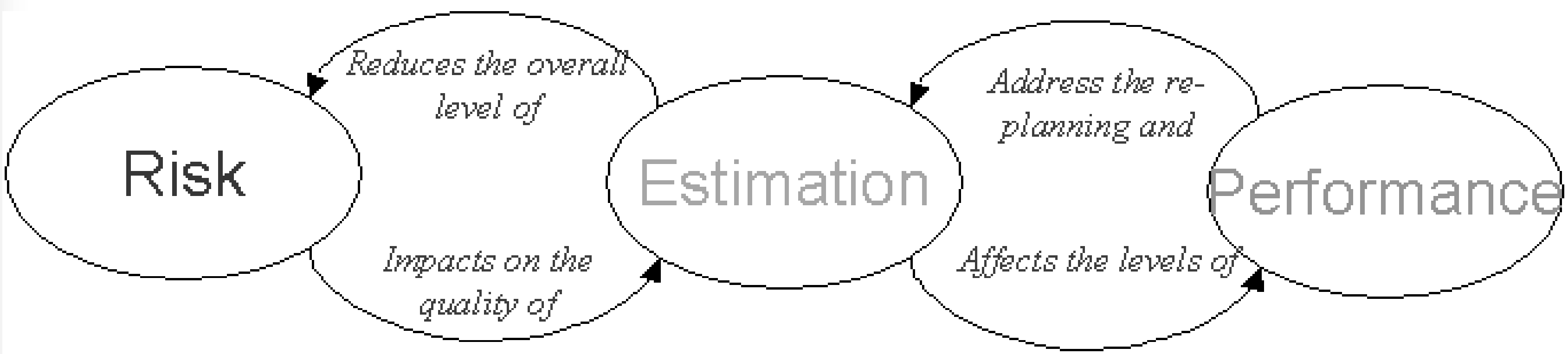
Starting point:

•LIME could be used also from the risk viewpoint (Gotterbarn, 2002)

- ✓ it could handle a partial and implicit risk evaluation and rating, with the concurrent presence of several groups of stakeholders in evaluating a project's performance

Some basic questions:

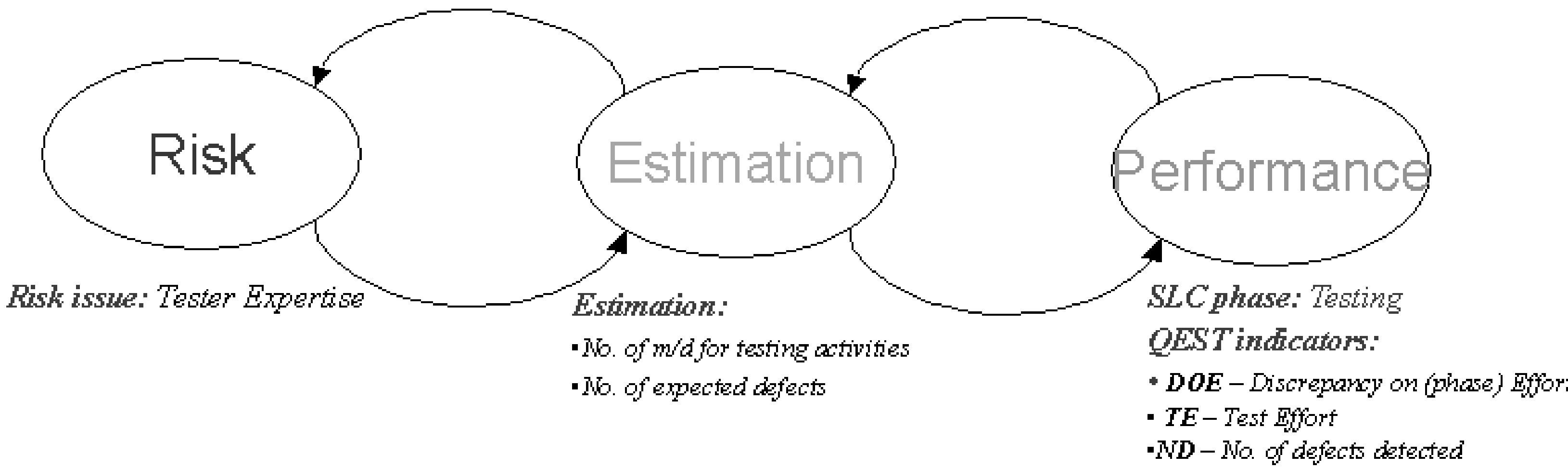
Q1*) what kind of relationship exists between SLC phase performances and risk in each phase?*



R-LIME: improving the LIME model with RBM

R-LIME: the Risk dimension extension

***Q2**) how are risk assessment and performance values to be related?*

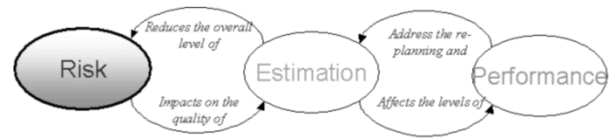


***Q3**) what is the appropriate time for execution of a revised performance calculation?*

- ✓ at the end of each SLC phase, the results obtained in the phase review meeting can be used for re-estimating resources for the next project phase, on the basis of a number of parameters

R-LIME: improving the LIME model with RBM

R-LIME: an example (Risk)



Hp - Different levels:

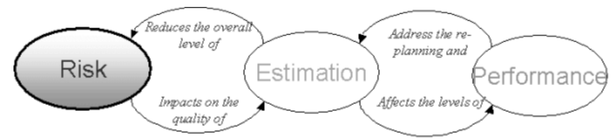
- WBS (L1: Testing phase)
- RBS (L1: Program Constraints; L2: Resources)
- Goal: assessing risk about resources assigned to the SLC testing phase

• Staff risk is rated R=108 (29% of the overall Resource risk)
• Within the SLC phases, the higher staff risk is from Testing people (R=30; R%=21%)

		RBS				
		Program Constraints				
		Resources				
		Staff	Budget	Facilities	**R**	**R%**
WBS	Analysis	20	25	60	**105**	*28*
	Design	15	30	10	**55**	*15*
	Coding	18	20	25	**63**	*17*
	Testing	30	35	15	**80**	***21***
	Maintenance	25	25	25	**75**	*20*
	R	**108**	**135**	**135**	**378**	**100**
	R%	***29***	*36*	*36*	**100**	

R-LIME: improving the LIME model with RBM

R-LIME: an example (Risk)



- **Reason**: after a project risk review, an internal defect rate higher than expected was detected
- **Decision**: the risk mitigation action was to substitute three senior testers in place of the five junior ones initially hired in the project team)
- Effect: after a project risk re-assessment, the risk level decreased (R’=10; R%=17%)

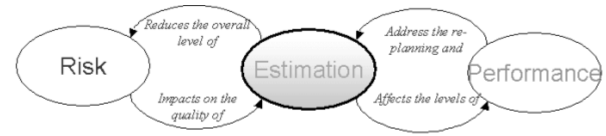
			RBS					
			Program Constraints					
			Resources					
			Staff	Budget	Facilities	**R**	**R%**	**Staff R%**
WBS	**Testing**	**R**	30	35	15	**80**	**21**	8
		R'	**10**	24	25	**59**	17	3
		%Diff.	**-67**	**-31**	**67**	**-26**	**-22**	**-5**
		Rel-Ind						

PDR (FP/WE) - Project Delivery Rate
DD (FP/ND) - Inverse of Defect Density
DDR (FP/ET) - Duration Delivery Rate
…

recalculated on R=358 (378-20)

R-LIME: improving the LIME model with RBM

R-LIME: an example (Estimation)



• **Effect**: a risk reduction was noted, with an impact on the estimations of some indicators (PDR; DD; DDR)

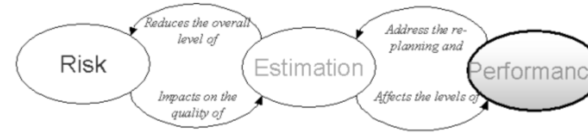
	Aspects	Initial Estimation	Risk assessment (%)	Estimation revised
Testing SLC phase	**Effort**	36 m/d	**-66,67** to be applied on the indicators related to that risky event (**PDR**)	**12 m/d**
	Duration	12 calendar days	**DDR**	**4 calendar days**
	Defectability	10 defects	**DD**	**5 defects**

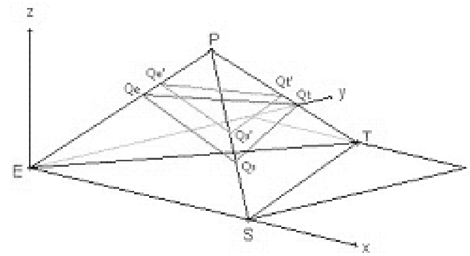
Hp:
Testing activities must be conducted by 3 FTE (full-time equivalent) people

• **Follow-up**: discuss and verify those hypothesis against historical data (where available) and/or brainstorming sessions within the project team

R-LIME: improving the LIME model with RBM

R-LIME: an example (Performance)





RATIO	RATIO ID.	RATIO NAME	DIM (E, S,T)	Rmin	Rmax	Observ. Value	Normalised Value
m1/m2	FFP/WE	Project Delivery Rate (PDR)	E	2,0000	6,6870	4,0000	0,4285
m3/m1	QRC / FFP	% of reused code	E, T	0,0000	0,5000	0,1000	0,2000
m5/m2	WE / WER	% of WE spent for reuse	E	0,1000	0,5000	0,3000	0,5000
m14/m1	C90 / FFP	Stability Ratio (SR)	S, T	0,0010	0,0095	0,0050	0,4706
m1/m11	FFP / ND	Inverse of Defect Density (DD)	T	1,0000	1000,0000	111,1111	0,1102
m6/m10	TTT / RTT	Training Time Coverage (TTC)	S	0,0000	1,0000	0,6667	0,6667
m1/m8	FFP / ET	Duration Delivery Rate (DDR)	E, T	142,0000	250,0000	200,0000	0,5370
q	Rxy (experience / usability)		S	0,0000	1,0000	0,4000	0,4000
q	Rxy (education / usability)		S	0,0000	1,0000	0,4300	0,4300
q	Rxy (age / usability)		S	0,0000	1,0000	0,3000	0,3000
q	Rxy (ideal / real evaluation)		S	0,0000	1,0000	0,6000	0,6000

Legend: q=derived from questionnaire

RATIO	RATIO ID.	RATIO NAME	DIM (E, S,T)	Rmin	Rmax	Observ. Value	Normalised Value
m1/m2	FFP/WE	Project Delivery Rate (PDR)	E	2,0000	6,6870	4,0000	0,4285
m3/m1	QRC / FFP	% of reused code	E, T	0,0000	0,5000	0,1000	0,2000
m5/m2	WE / WER	% of WE spent for reuse	E	0,1000	0,5000	0,3000	0,5000
m14/m1	C90 / FFP	Stability Ratio (SR)	S, T	0,0010	0,0095	0,0050	0,4706
m1/m11	FFP / ND	Inverse of Defect Density (DD)	T	1,0000	1000,0000	111,1111	0,1102
m6/m10	TTT / RTT	Training Time Coverage (TTC)	S	0,0000	1,0000	0,6667	0,6667
m1/m8	FFP / ET	Duration Delivery Rate (DDR)	E, T	142,0000	250,0000	200,0000	0,5370
q	Rxy (experience / usability)		S	0,0000	1,0000	0,4000	0,4000
q	Rxy (education / usability)		S	0,0000	1,0000	0,4300	0,4300
q	Rxy (age / usability)		S	0,0000	1,0000	0,3000	0,3000
q	Rxy (ideal / real evaluation)		S	0,0000	1,0000	0,6000	0,6000

Legend: q=derived from questionnaire

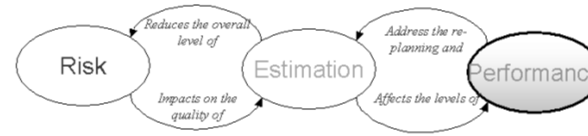
Initial p calculation → p calculation revised (p_r)

Substitute re-estimated values

- **Final step**: translation and usage of such new values for recalculating the new p value (p_r) using the QEST calculation formula

R-LIME: improving the LIME model with RBM

R-LIME: an example (Performance)



Hp: SLC Testing p=0.7; after actions, p_r =0.75 (+5% performance)

Comments:

✓ new resources assigned to testing activities had the right set of skills but the amount of risk impacting their effort estimation and schedule was too high

Possible candidate improvement actions:

✓ skill inventory detail

✓ cost figures per professional

✓ historical data on avg productivity figures from project splitted by SLC phase and avg no. of people involved in each SLC phase

✓ ...

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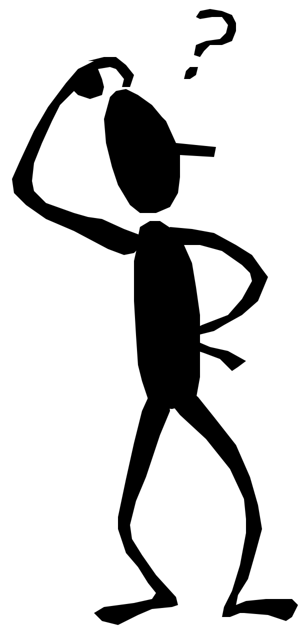
Conclusions & Prospects

- The introduction of RM best practices is becoming critical for organizations, moving progressively toward a more quantitative approach to risk
- RBM (Risk Breakdown Matrix) technique is a recent proposal moving on this path, mixing WBS and RBS
- LIME is a multi-dimensional model for estimating SLC phase performance levels (extending the QEST model to the whole SLC); the integration of RBS into LIME was presented, generating R-LIME (taking into account QEST nD representation as a basic model for each SLC phase)
- Risk, Estimation and Performance are linked in a cause-effect chain, at the base of R-LIME
- A calculation example was presented, discussing how to manage in a continuous improvement manner results from the model
- Further evolutions of R-LIME to be investigated will be:
  - A more extensive simulation using ISBSG R9 data
  - The derivation of estimation models for QEST/LIME using ISBSG R9 data

Q & A



Thank you!

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