ENGINEERING

AUTOMOTIVE SPIN ITALIA

7° Automotive SPIN Italy Workshop

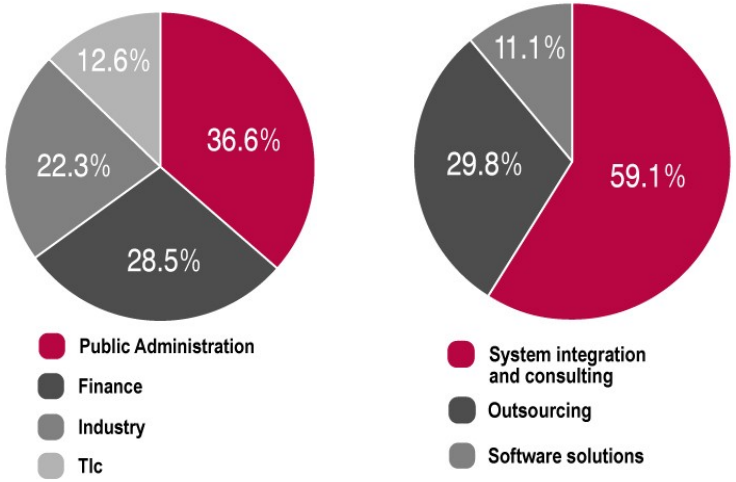
Pisa, May 21st 2010

COSMIC

A new method for measuring software functional size

Luigi Buglione, *Ph.D.*
Process Improvement & Measurement Specialist
Industry Business Unit
Engineering.IT

- The **first Italian ICT player**
  - more than 730 M/€ revenues
  - 1000 clients
  - 6,300 IT specialists



		PA & HC	Finance	Industry	TELCO	Utilities
Research and Development						
System Int. & Consultancy	%	46	70	54	80	80
Outsourcing	%	35	10	27	10	
Software	%	19	20	19	10	20

ERP | IT Security | ECM

Managed Operations | Plant Management System | Broadband & Media

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Goals of the presentation

- ✓ **G1.** Present the COSMIC FSM method and principles
- ✓ **G2.** Discuss main changes/improvements against the so-called 1°-generation FSM methods
- ✓ **G3.** Show possible scenarios for applicability of COSMIC Function Points (CFP) in the Automotive sector

- **Introduction**
  - How requirements can be perceived
  - A bit of humour…
- **Functional Size Measurement (FSM) Methods**
  - History: the first 30 years
  - The 'productivity paradox'
  - 1st generation FSM methods
- **COSMIC**
  - Origins & Evolution
  - Reference documents
  - Scope of Application
  - General Concepts
  - Counting Principles
  - Case Study: the Rice Cooker
  - Benchmarking data
  - Conversions with other FSMM
- **Conclusions & Prospects**
- **Q & A**

One year ago...


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AUTOMOTIVE SPIN ITALIA
5° Workshop
AutomotiveSPIN Italia
Milano, 4 Giugno 2009
Top Metrics for SPICE-compliant projects
Luigi Buglione
Engineering.it
luigi.buglione@eng.it
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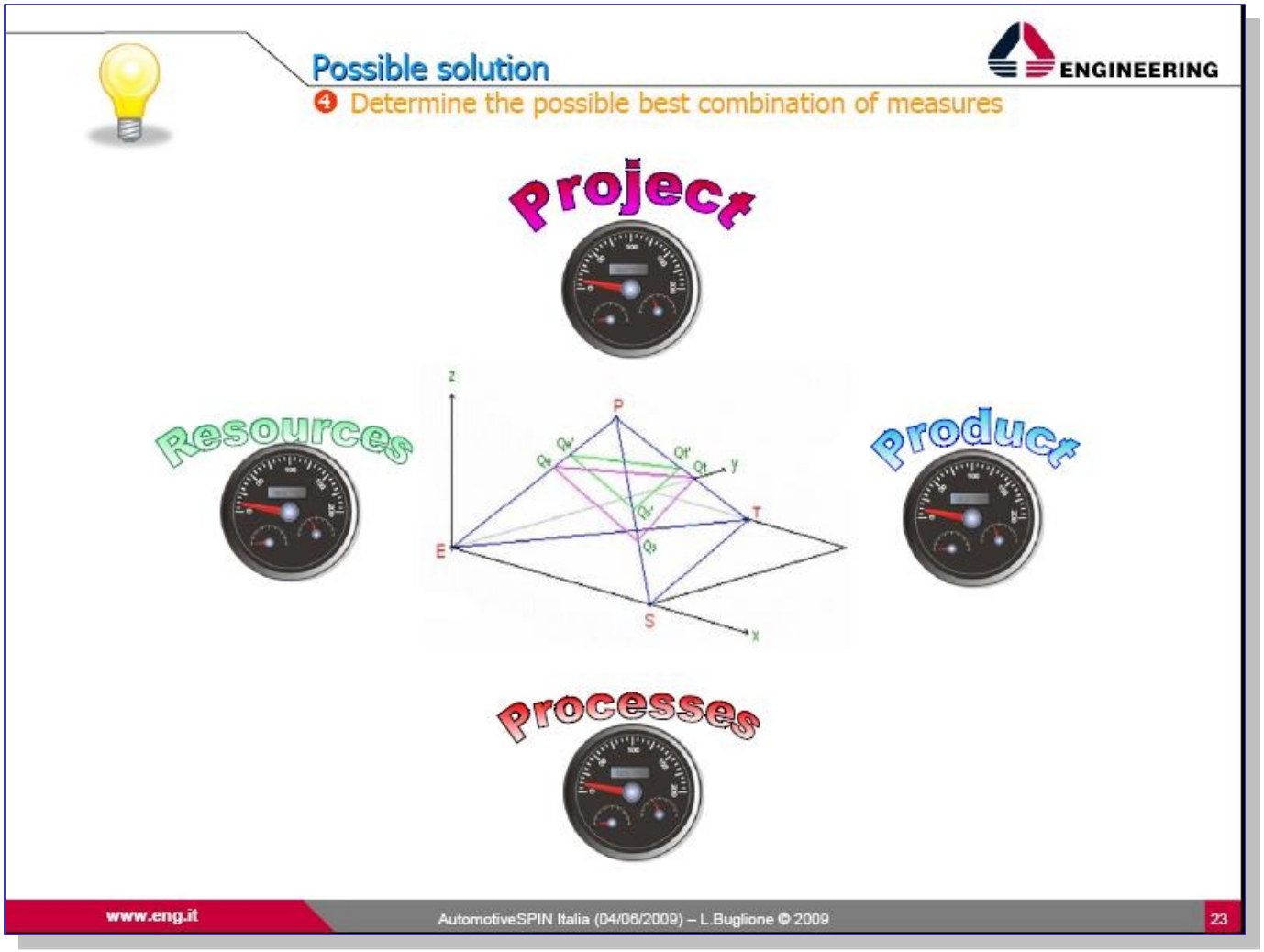
Possible solution
ENGINEERING
Determine the possible best combination of measures
Project
Resources
Product
Processes
z
P
E
T
S
y
x
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One year ago...

Possible Solution

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❷ Determine the list of most representative measures (1)

Entity	Attribute	Measure	Threshold	A-SPICE
Project	Planning compliance	Effort (man/hrs) per SLC phase, per iteration (abs, %)	(profiles on hist.data)	MAN.3
Resource	Time	% of open complaints / notes for delaying in providing the agreed furnitures (tracked) per contract	≤10%	ACQ.4
Process*	Time performance	SPI (Schedule Performance Index)	ongoing	MAN.3
Process*	Cost performance	CPI (Cost Performance Index)	ongoing	MAN.3
Process	QA performance	% of non-conformances still open	≤15%	SUP.1
Process*	Maturity	Problem Reports (PR) by status (open, closed)	(profiles on hist.data)	SUP.9
Process	Changeability	Avg Change Requests (CR) working time by status	(profiles on hist.data)	SUP.8 - SUP.10
Process*	Planning reliability	Requirements Volatility of 'Scope Creep' Index (# of modified/new UR not formally traced / tot. # UR) by iteration	≤10%	ENG.4
Product*	Code Length	Kilo Lines of Code (KLOC) [system, function, module] *c.a 5 functions per module*	(abs, 100-150, 700-1000)	ENG.4
Product*	Functional Size	Functional Size (fsu) [system]	(abs)	ENG.4

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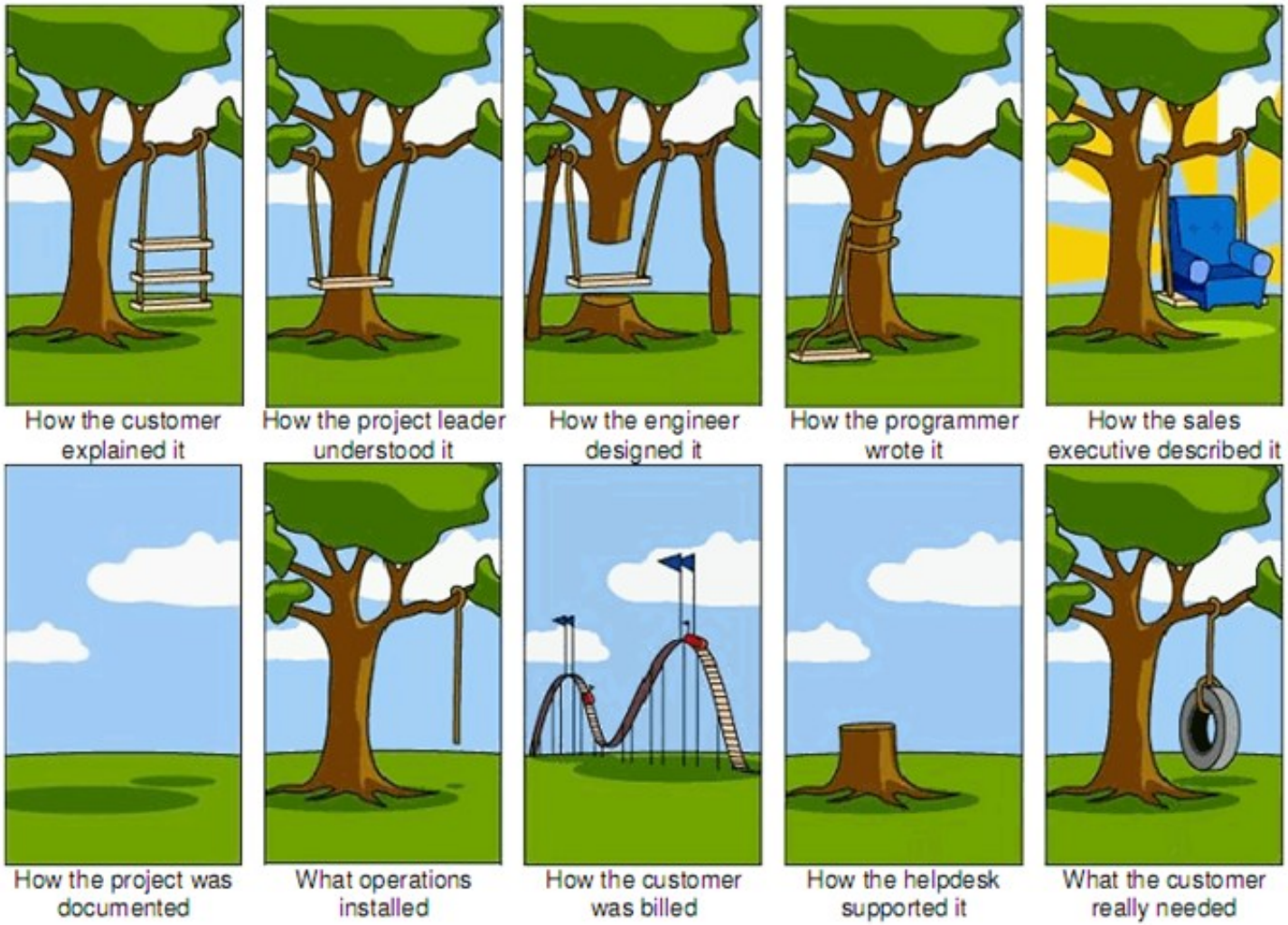
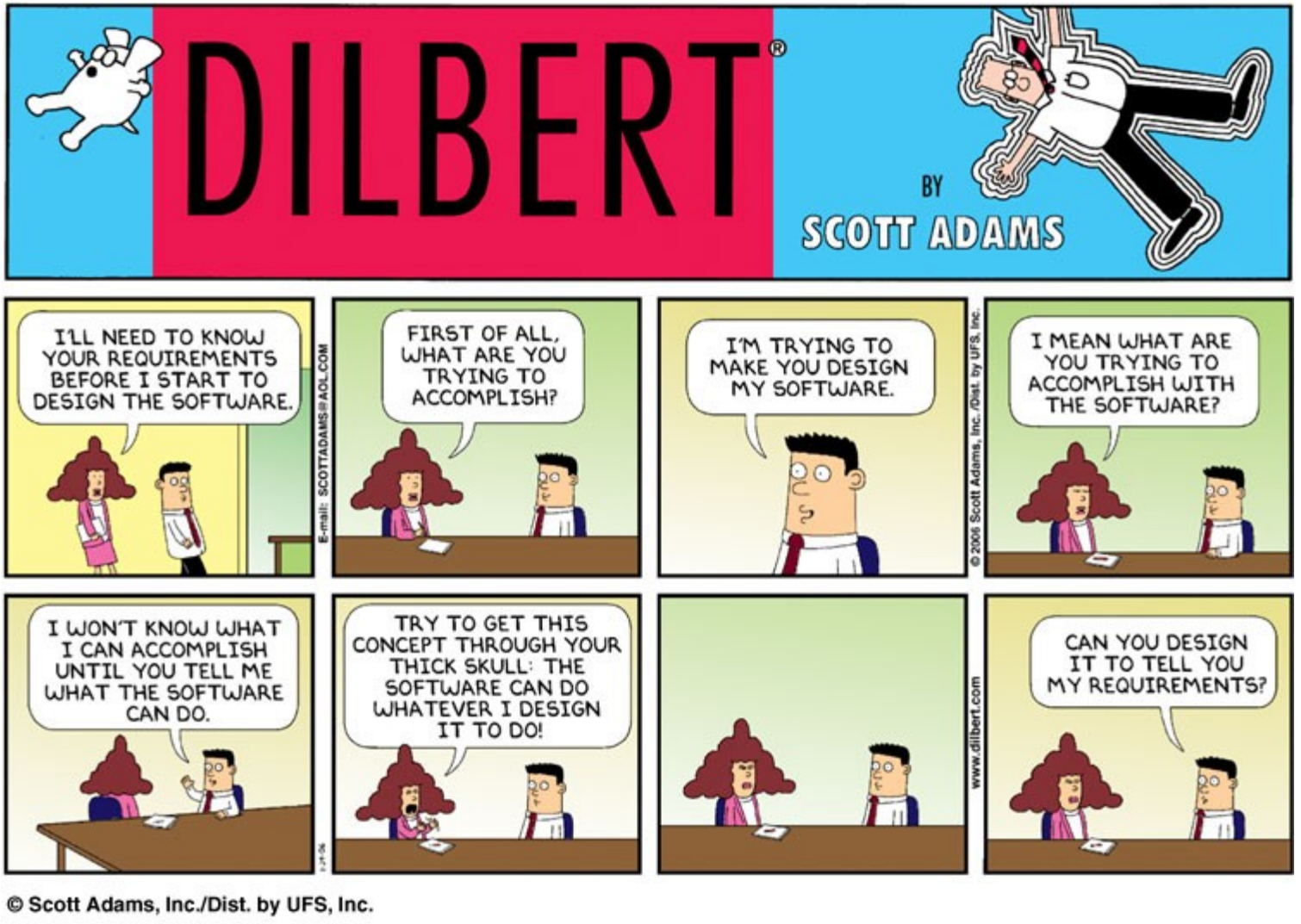
How requirements can be perceived…

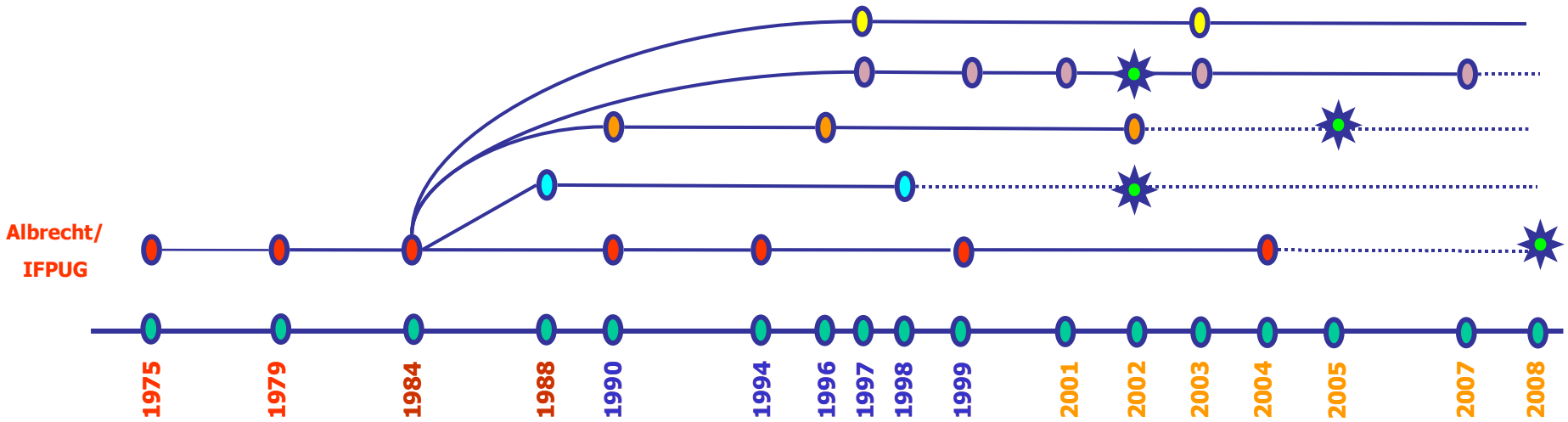


Dilbert on Requirements…



FSM Methods

History: First 30 years



- ✓ **COSMIC-FFP** (ISO/IEC **19761:2003**): v2.1 (2002), first FSM method (2°generation) standardized by ISO
- ✓ **IFPUG FPA** (ISO/IEC **20926:2009**): v4.3 (2009), it explicitly excludes VAF
- ✓ **UKSMA MarkII FP** (ISO/IEC **20968:2002**): v1.3.1 (1998), it explicitly excludes corrective factors
- ✓ **NESMA FPA** (ISO/IEC **24570:2005**): update of the Dutch v2.0 (1998) up to v2.1, mostly devoted to enhancement projects
- ✓ **FISMA FPA** (ISO/IEC **29881:2008**): the v1.1 Finnish method, including some BFC (Base Functional Components) different than other FSM methods

Each method has its own CPM (*Counting Practice Manual*) or MM (*Measurement Manual*) with details about "how" counting the *points*.

The 'productivity paradox': LOC

	Assembler version	Ada version	Difference
Source code size	100.000	25.000	-75.000
Activity in PM:			
• requirements	10	10	0
• design	25	25	0
• coding	100	20	-80
• documentation	15	15	0
• integration & test	25	15	-10
• management	25	15	-10
Total Effort	**200**	**100**	**-100**
Total Cost	**$1.000.000**	**$500.000**	**-$500.000**
Cost per line	**$10**	**$20**	**+10$**
Lines per month	**500**	**250**	**-250**

Source: C.Jones, *What are Function Points?*, SPR website, URL: http://web.archive.org/web/19990421055424/www.spr.com/library/0funcmet.htm

The 'productivity paradox': FP

	Assembler version	Ada version	Difference
FP	300	300	0
Activity in PM:			
• requirements	10	10	0
• design	25	25	0
• coding	100	20	-80
• documentation	15	15	0
• integration & test	25	15	-10
• management	25	15	-10
Total Effort	**200**	**100**	**-100**
Total Cost	**$1,000,000**	**$500,000**	**-$500,000**
Cost per FP	**$3.333**	**$1.666**	**-$1.667**
FP per month	**1.5**	**3.0**	**1.5**

Source: C.Jones, *What are Function Points?*, SPR website, URL: http://web.archive.org/web/19990421055424/www.spr.com/library/0funcmet.htm

The International association managing since 1986 updates of Albrecht's FPA counting rules is the International Function Point Users Group (IFPUG), composed worldwide from 700+ members – www.ifpug.org

Some active SMAs:

- ✓ **GUFPI-ISMA** (Gruppo Utenti Function Point Italia – Italian Software Metrics Association)
- ✓ **UKSMA** (UK Software Metrics Association)
- ✓ **NESMA** (Netherlands Software Metrics Association)
- ✓ **FISMA** (Finnish Software Measurement Association)
- ✓ **DASMA** (Deutschsprachige Anwendergruppe für Software-Metrik und Aufwandschätzung)
- ✓ **QESP** (Quantitative Enterprise Software Performance, ex ASMA)
- …

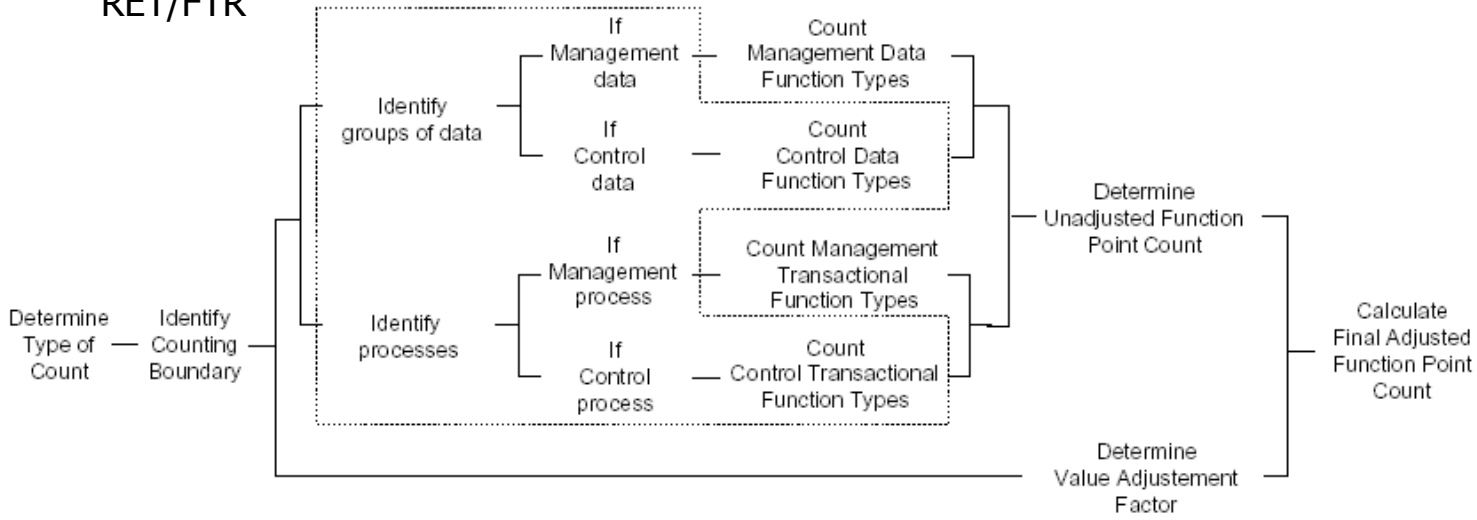
- **Which ones?**
  - ✓ FSM methods having in their counting scope the solely application layer
- **Limits and Scope of Applicability**
  - ✓ Application domains: IFPUG FPA not particularly feasible to non-MIS software (e.g. real-time apps, embedded software, etc.)
  - ✓ Scope: Software system seen only at the *application layer* level
  - ✓ Viewpoint: The *end user* one
  - ✓ Weighting system: 1°gen- FSM methods use a weighting system for their BFCs, based on a project sample (typically not so huge)
  - ✓ Possible consequences: not performant usage of fsu for building effort and cost estimation models

Possible solutions

- ✓ Create a new FSMM, aligned with ISO/IEC 14143-x series rules and criteria, with the goal to overcome the above mentioned limits

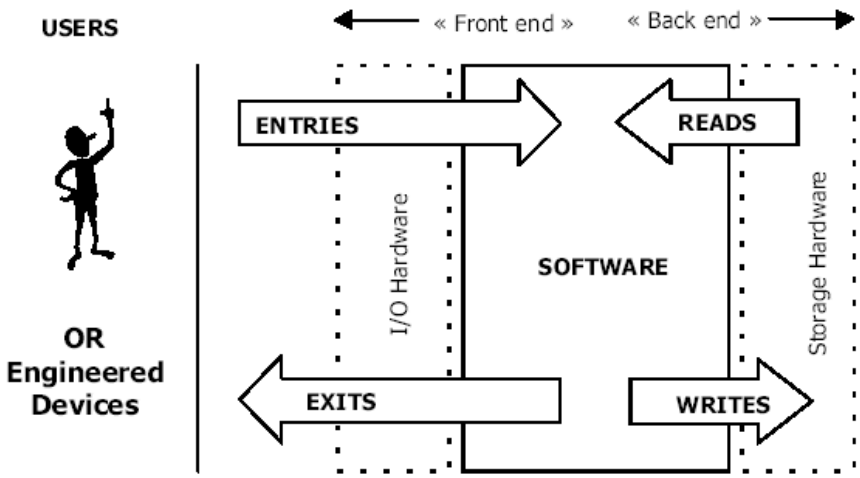
- **Origins**
  - ✓ **Main Evolutions**:
    - ❖ Full Function Points (FFP, UQAM, 1997) → v1.0
    - ❖ COSMIC-FFP (1999) → v2.0
    - ❖ COSMIC (2007) → v3.0
  - ✓ **COSMICON**: Common Software Measurement Initiative Consortium
    - ❖ Voluntary initiative born in 1998
    - ❖ Documents and rules always in the publicly available
    - ❖ COSMIC (v2.2) become an ISO standard yet in 2003 (ISO/IEC 19761)
    - ❖ Currently it has Board Members from Europe, North America, Asia and Australia
    - ❖ URL: www.cosmicon.com

- **v1.0 – FPA Extension for R/T software**
  - ✓ Modify IFPUG counting rules, distinguishing:
    - Management Types → to be counted according IFPUG rules
    - Control Types → to be counted according new FFP rules and to be added to the other *points*
  - ✓ BFC:
    - Control Data Types (**UCG** – Updated Control Group; **RCG** – Read-only Control Group)
    - Control Transactional Data Types (ECE – External Control Entry, **ECX** – External Control eXit, **ICR** – Internal Control Read, **ICW** – Internal Control Write)
  - ✓ Weighting System:
    - A weighting system was in place, as for IFPUG FPA, taking care of DET but not RET/FTR



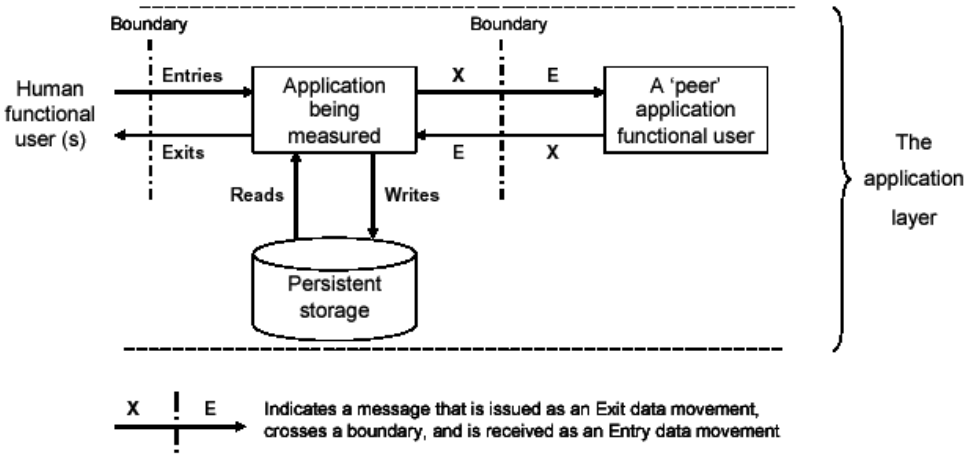
Souce: St.Pierre D., Maya M., Abran A., Desharnais J.M., *Full Function Points: Function Points Extension for Real-Time Software, Concepts and Definitions*, Technical Report 1997-03, UQAM, Montréal, Canada

- **v2.0 – method 'per-se'**
  - ✓ Main changes from FFP v1.0:
    - ❖ No more differences between Management and Control Types, → 'data movement'
    - ❖ Two macro-phases: Mapping and Measurement
    - ❖ Introduced the 'layer' and 'viewpoint concepts'
    - ❖ Convertibility from/to other FSMM (included FFP v1.0 and IFPUG FPA v4.1)
  - ✓ BFC:
    - ❖ Possible 'data movements': **E** – Entry, **X** - eXit, **R** – Read, **W** –Write
  - ✓ Weighting System:
    - ❖ Deleted the weighting system
    - ❖ Each 'movement' counts 1 cfsu (COSMIC functional size unit)

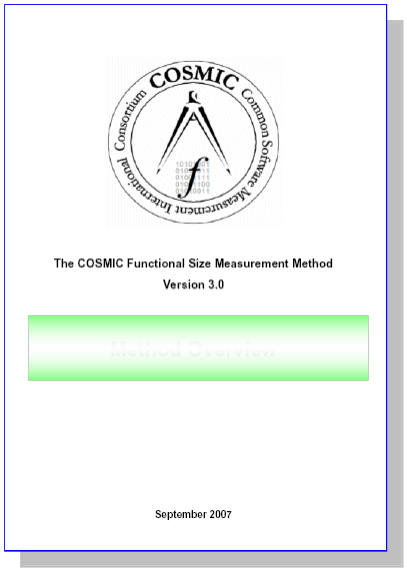


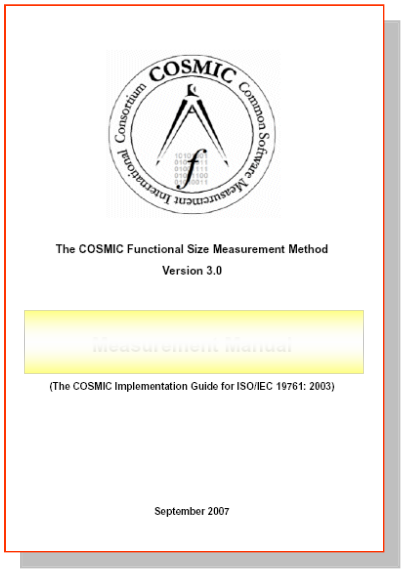
Source: Abran A., Desharnais J.M., Oligny S., St-Pierre D., Symons C., *COSMIC-FFP Measurement Manual*, v2.0, October 1999, COSMICON

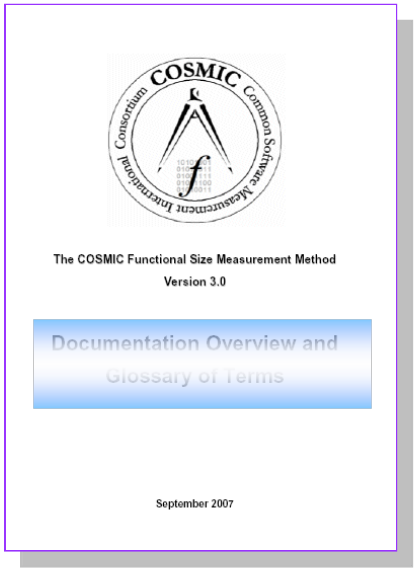
- **v3.0 – Refining the method**
  - ✓ Main changes from COSMIC-FFP:
    - Three macro-phases: Measurement Strategy, Mapping and Measurement
    - Granularity level in the counting
    - Clear distinction between 'principles' and 'rules'
    - Maggiore e migliore strutturazione del dataset di documenti e guide
    - Series of Guidelines (GL) per application domain
    - Possibility of Local extensions
  - ✓ BFC:
    - **E** – Entry, **X** - eXit, **R** – Read, **W** –Write
  - ✓ Size Unit:
    - Change of name from *cfsu* to **CFP** (COSMIC Function Point)

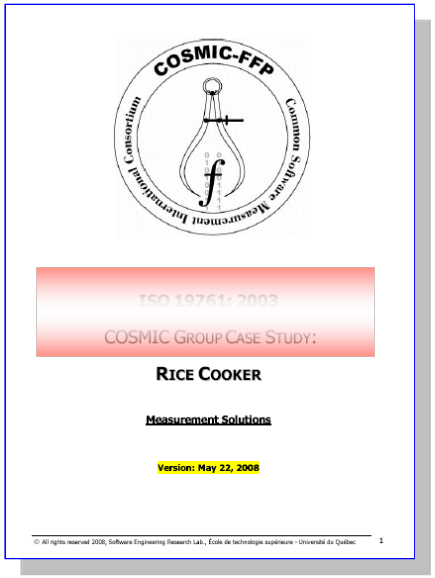


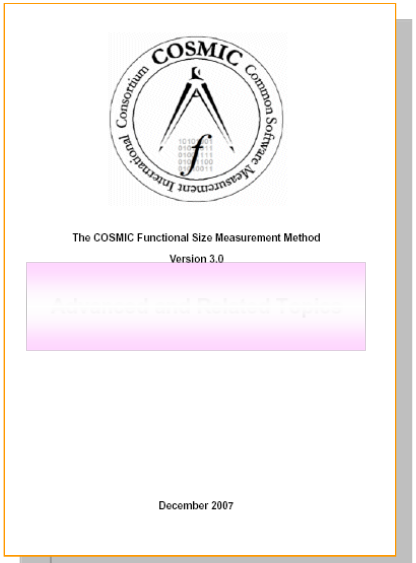
Source: Abran A., Desharnais J.M., Oligny S., St-Pierre D., Symons C., *COSMIC-Measurement Manual*, v3.0, September 2007, COSMICON

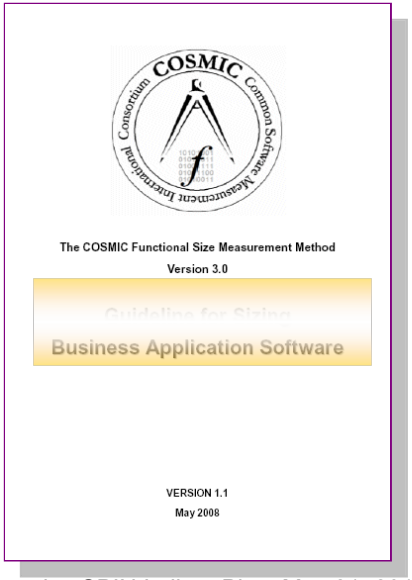

The COSMIC Functional Size Measurement Method
Version 3.0
Method Overview
September 2007

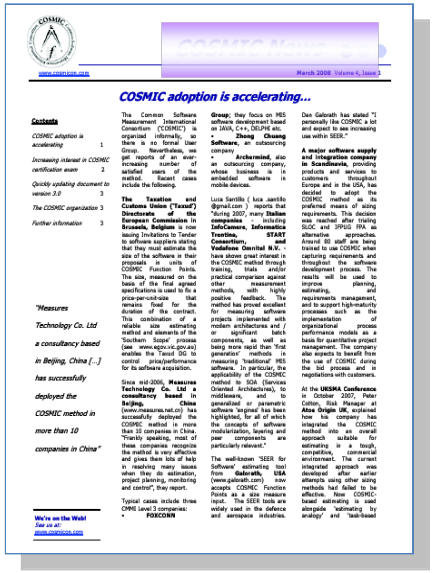

The COSMIC Functional Size Measurement Method
Version 3.0
Measurement Manual
(The COSMIC Implementation Guide for ISO/IEC 19761: 2003)
September 2007

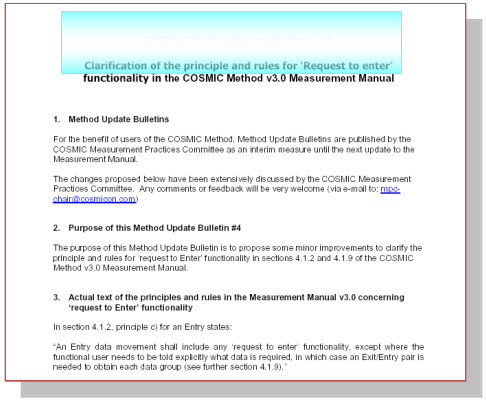

The COSMIC Functional Size Measurement Method
Version 3.0
Documentation Overview and Glossary of Terms
September 2007


COSMIC-FFP
ISO 19761: 2003
COSMIC GROUP CASE STUDY:
RICE COOKER
Measurement Solutions
Version: May 22, 2008

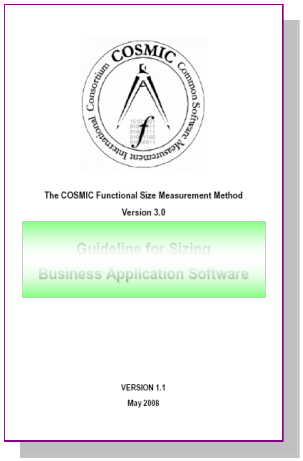

The COSMIC Functional Size Measurement Method
Version 3.0
December 2007


The COSMIC Functional Size Measurement Method
Version 3.0
Business Application Software
VERSION 1.1
May 2008


COSMIC adoption is accelerating...
Contents
"Measures Technology Co. Ltd a consultancy based in Beijing, China [...] has successfully deployed the COSMIC method in more than 10 companies in China"


Clarification of the principle and rules for 'Request to enter' functionality in the COSMIC Method v3.0 Measurement Manual
1. Method Update Bulletins
2. Purpose of this Method Update Bulletin #4
3. Actual text of the principles and rules in the Measurement Manual v3.0 concerning 'request to Enter' functionality

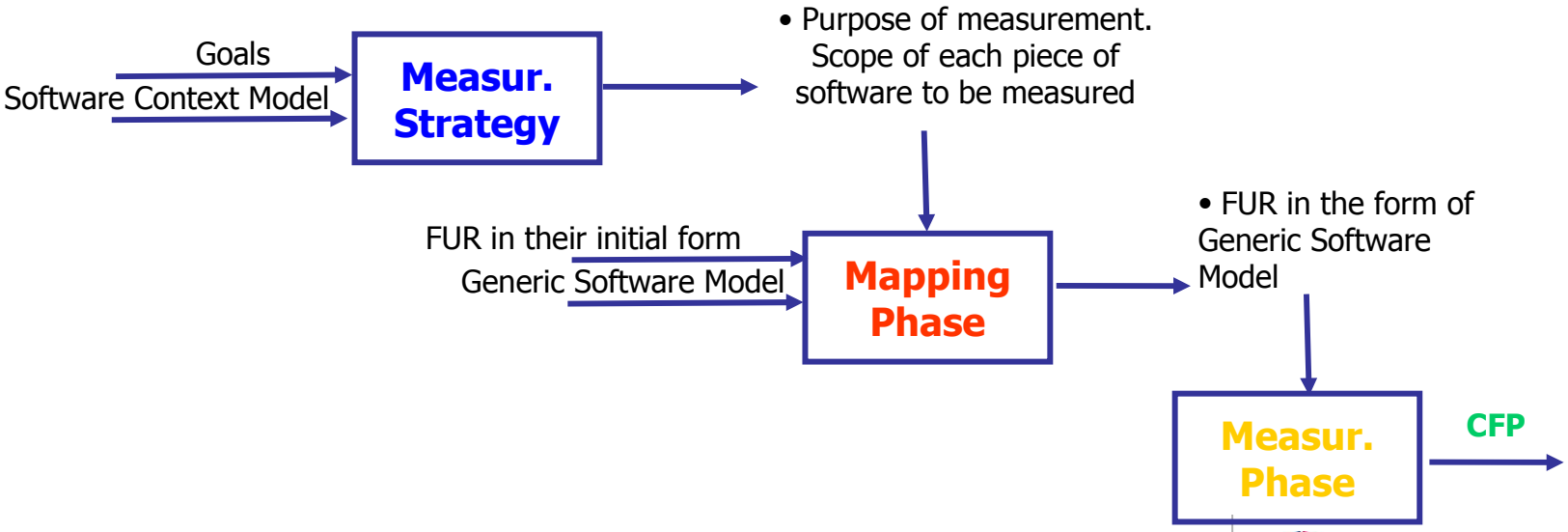
- **Applicability**
  - ✓ COSMIC can be adopted for calculating the functional size of a software
  - ✓ It is valid both for the "business" than the "real-time" domains
    - Nei sistemi business si considerano in più quegli aspetti
    - Nel real-time si catturano quindi anche tutti gli eventi di controllo/attivazione
  - ✓ Available guidelines (GL) for sizing...
    - Business Application Software (BAS), v1.1 (2008)
    - Datawarehouse (2009)
    - Real-time (2010)
    - SOA (2010)

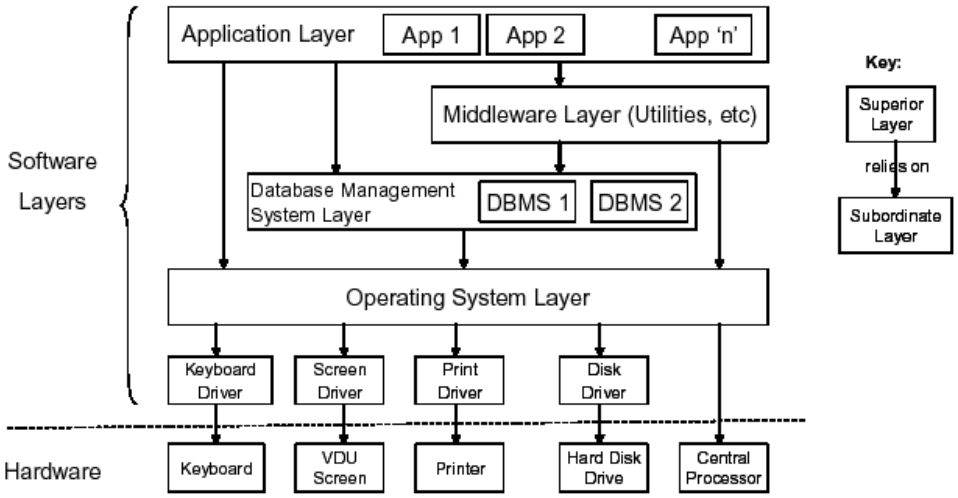


- **Non-Applicability**
  - ✓ COSMIC is not viable for other types of software…
    - …mathematical-algorithmic
    - …managing business rules
    - …expert and forecasting systems (e.g.weather report systems)
    - …computer games

Complexity

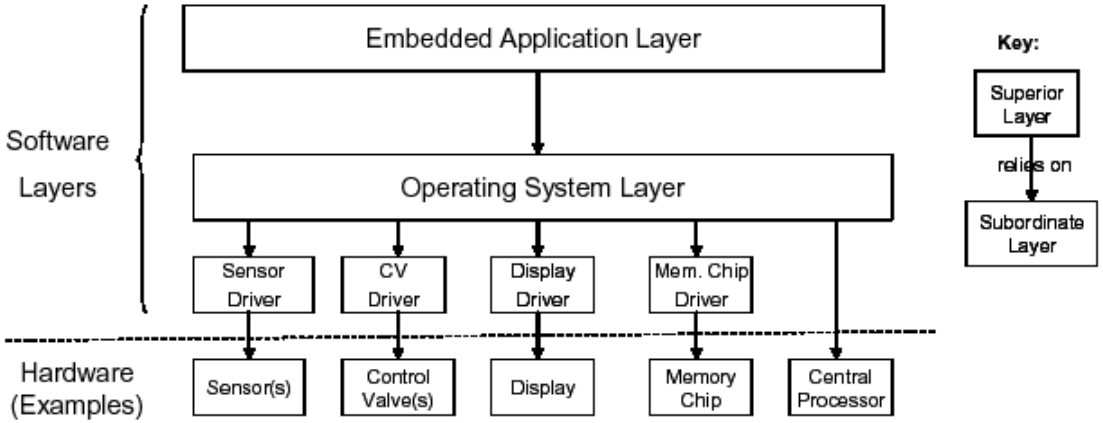
- COSMIC is a 2°generation FSM method
  - 4 BFC, no weighting system, each data movement counts as 1 CFP
  - 3 macro-phases: Measurement Strategy, Mapping and Measurement
  - Software Models:
    - ✓ Software Context Model → representation of the software system to measure
    - ✓ Generic Software Model → generic representation with the 4 data movement (E, X, R, W)
  - **User**: not only end-users, but also different viewpoints (with different views on software)
  - **Layer**: porzione risultante dalla divisione funzionale dell'architettura software (hw/sw)
  - **Granularity level**: each functional process can be decomposed into sub-processes



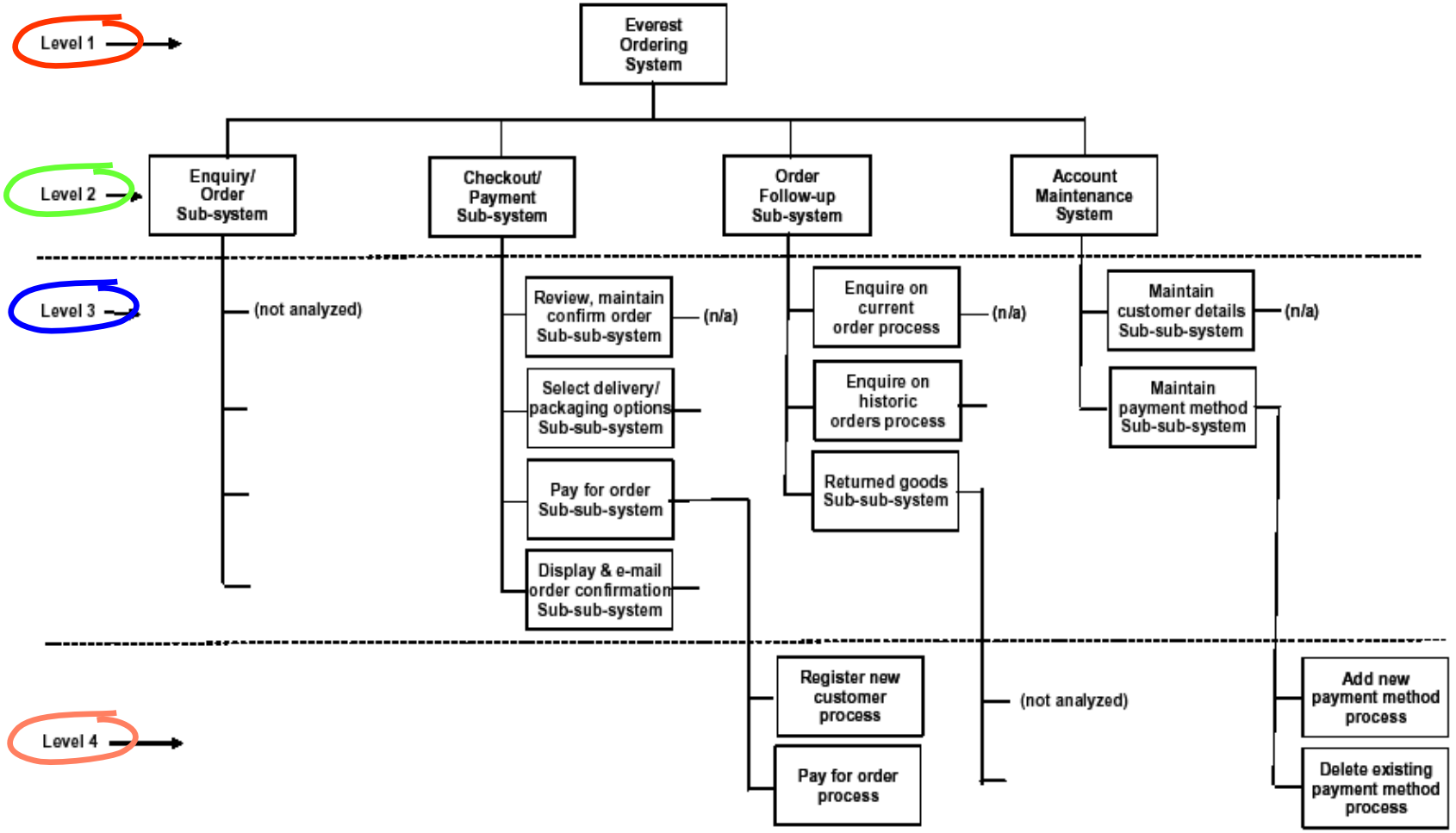


Architettura sistema business/MIS

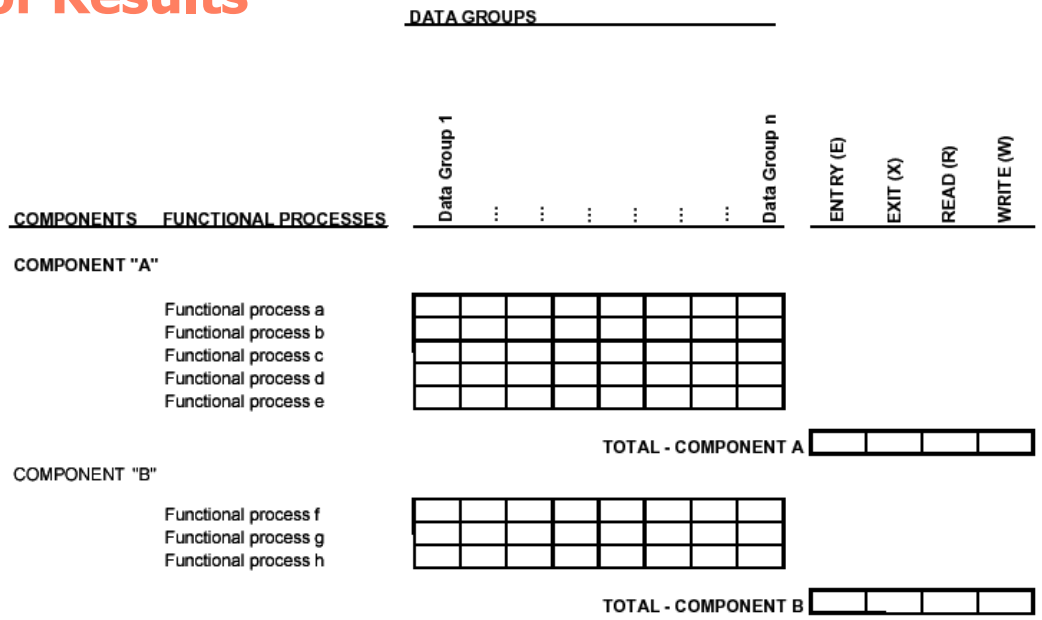
Architettura sistema R/T embedded



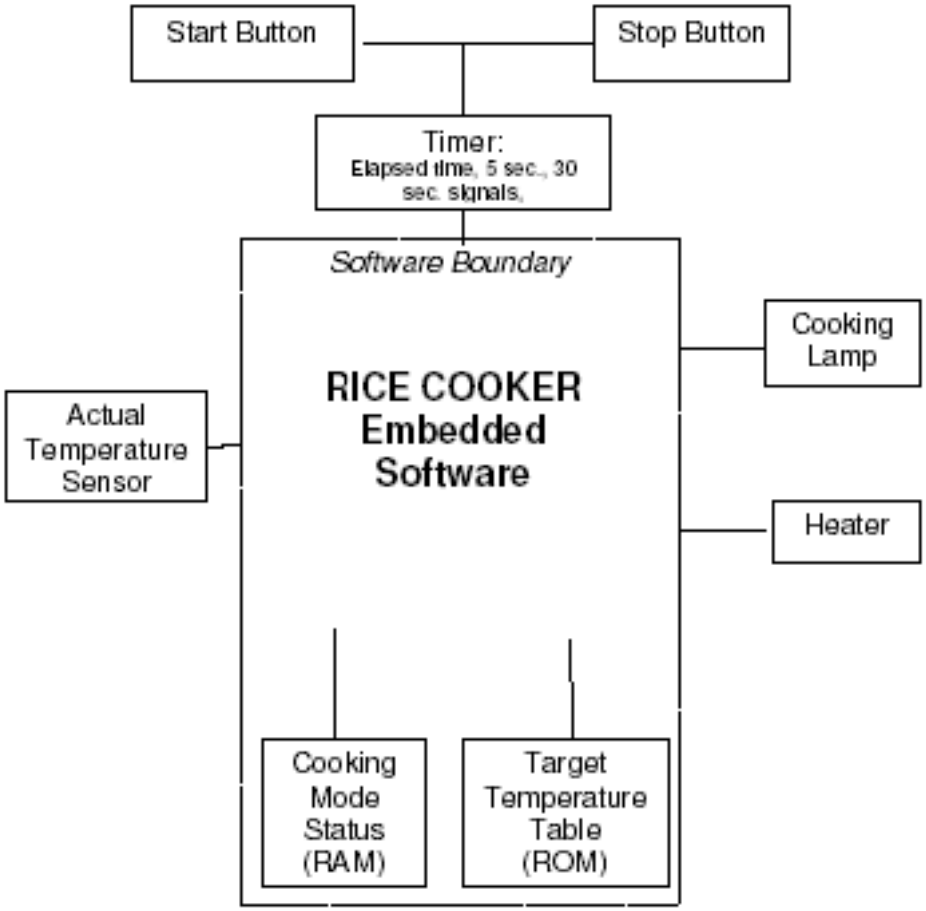
General Concepts: Level of Granularity



- **Counting principles**
  - ✓ Each data movement (E, X, R, W) creates 1 CFP
  - ✓ Functional size of a functional process = sum of frequencies of its BFCs
  - ✓ COSMIC Function Points (CFP) own the additive property
    - ❖ Functional size of a software = sum of the size of its functional processes derived from FURs, according to what established in the Measurement Strategy phase
    - ❖ Functional size of a modified software system = sum of the sizes for **added**, **changed** and **deleted** data movements
- **Reporting of Results**



Case Study: Rice Cooker (v3.0)



No.	Funct. Process	Triggering Event	Data Movement Description	Data Group	DM Type	CFP	CFP
1	Select target temperature	30sec. Timer Signal	Receive Triggering event Read Cooking mode RAM Receive Elapsed Time Read Temperature relationship from ROM Write target temperature	30sec. Timer Signal Cooking mode Elapsed time Signal Temperature relationships Target temperature	E R E R W	1 1 1 1 1	**5**
2	Control Heater	5sec. Timer Signal	Receive Triggering event Receive Actual Temp. from Sensor Read Target temperature Fissa il comando Calore (On/Off)	5sec. Timer Signal Actual Temperature Target Temperature HeaterTurn On/off command	E E R X	1 1 1 1	**4**
3	Control Cooking Lamp	Elapsed Time Signal	Receive Triggering event Send Cooking Lamp Command	Elapsed time Signal Cooking lamp turn on/off command	E X	1 1	**2**
						Tot	**11**

An Invitation from COSMIC and the ISBSG
Help establish the foundation COSMIC-FFP Benchmarks

COSMIC (the Common Software Measurement International Consortium and the ISBSG (International Software Benchmarking Standards Group) have launched a joint study to collect data on software projects which will be used to establish initial COSMIC-FFP based performance benchmarks. The publication of Guideline for the application of COSMIC-FFP for Business Application software (December 2005), is a good opportunity for this second study.
ISBSG is an open repository and does not sanction any functional size measure. This organization relies on other sanctioning bodies (e.g., ISO) and industry at large to determine effective functional size measures. ISBSG utilizes these two factors in selecting which functional sizing measures will be incorporated into the data repository and contained within its analysis reporting.

Organisations that develop real-time, infrastructure, embedded or business application software and who wish to compare their projects' performance against that of their peers using the International Standard COSMIC-FFP method of sizing the software produced by their projects, are invited to join this study.
All organisations submitting data to the study on their software development and enhancement projects will receive a free copy of the benchmark report and private reports on how their projects' performance compares against the benchmarks.

The study process is as follows:

- Those interested in taking part in the study should contact one of the 'Interface' organisations listed below, or contact the ISBSG directly, to receive more detailed information about the study, (t he 'proposal'), information on the COSMIC-FFP method if needed and to obtain the ISBSG data collection forms.
- Participants measure the size of their projects using COSMIC-FFP, collect the other data on effort, elapsed time, performance-influencing factors etc, complete the ISBSG data collection forms and submit them to ISBSG by 31st October 2006. There is no limit on the number of projects that may be submitted.
- The ISBSG loads the data into its repository. This step guarantees organisational anonymity. New data are combined with existing data and analysed by ISBSG to produce the benchmarks.
- By the end of 2006, participants will receive from the ISBSG the common benchmark report distributed to all participants and a report showing how the individual project's performance compares against the new benchmarks. All free-of-charge.
- If required and agreed with the Interface organization, the latter may provide training and support in the use of the COSMIC-FFP sizing method and other support and assistance in participating in the benchmark study.

Joining this study presents a unique opportunity to gain insight into the performance of your software projects in ways which have not been possible until very recently and to draw on the support and experience of COSMIC and the ISBSG and of your preferred Interface organization if required.
Contact your nearest Interface organization, or the ISBSG directly, via the Contact List below.
Several organisations have already joined the first study. Why not join now?

Ton Dekkers
President ISBSG

- **COSMIC Benchmarking Initiative**
  - ✓ Proposal COSMIC w/ISBSG (2006-)
    - **Goal**: spreading the number of project data sized with COSMIC in the current ISBSG repository
    - **News**:
      - Simplified questionnaire than current standard version
      - Add the number of layers taken into account

ISBSG Delivering IT Confidence

- **ISBSG r11 (May 2009)**
  - ✓ 5052 projects, measured with different methods:
    - **345** projects measured with COSMIC (+203% than in r10)

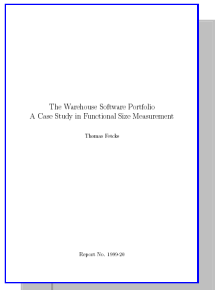
Enh	CFP	Eff m/d	Prod
Max	2003	5936.6	5.48
Avg	**170.1**	**548.9**	**0.72**
Median	**95.0**	**319.3**	**0.30**
Min	3	2	0.03

NewDev	CFP	Eff m/d	Prod
Max	2090	5907	40.87
Avg	**309.2**	**716.6**	**1.54**
Median	**182.0**	**350.7**	**0.45**
Min	8	1	0.02

- **Motivations for conversions**
  - ✓ "Save" the value from application portfolio counts yet done with another Fsm method (e.g. IFPUG)
- **Suggestions / Studies**
  - ✓ COSMIC "Advanced & Related Topics" v3.0, Chapter 3
    - ❖ Multiple 'native' count against *n* projects
    - ❖ Derive regression straight line/ curve from projects historical functional size data
    - ❖ Avoid to apply 'as-is' formulas

Author(s)	Data points	FP range	Formula	R^2
Fetcke (1999)	4	40-77	CFP = 1.1*FP_{IFPUG} – 7.6	**0.97**
Vogelezang & Lesterhuis (2003)	11	39-1424	CFP = 1.2*FP_{NESMA} - 87	**0.99**
Abran, Desharnais, Azziz (2005)	6	103-1146	CFP = 0.84*FP_{IFPUG} +18	**0.91**
Desharnais & Abran (2006)	14	111-647	CFP = 1.0*FP_{IFPUG} – 3	**0.93**
Van Heeringen (2007)	26	61-1422	CFP = 1.22*FP_{NESMA} - 64	**0.97**

- **Counting exercises with multiple FSM methods**
  - ✓ Fetcke T., The Warehouse Software Portfolio, Report No.1999-20, University of Magdeburg, 1999
  - ✓ Bundshuh M. & Dekkers C., *The IT Measurement Compendium. Estimating and Benchmarking Success with Functional Size Measurement*, Springer, 2008, ISBN 978-3-540-68187-8



Renault France

- ✓ Object of interest: ECU (Electronic Control Units)
- ✓ Effort Estimations for sw development done in the past using IFPUG FPA method and COCOMO technique
- ✓ COCOMO was unsuccessful after a first experimentation
- ✓ IFPUG and COSMIC experimentation started in mid 2008
- ✓ ECU with a set of specifications under Matlab/Simulink tools with also textual requirements
- ✓ 9 modules under the expermentation, sized with both methods (IFPUG and COSMIC)

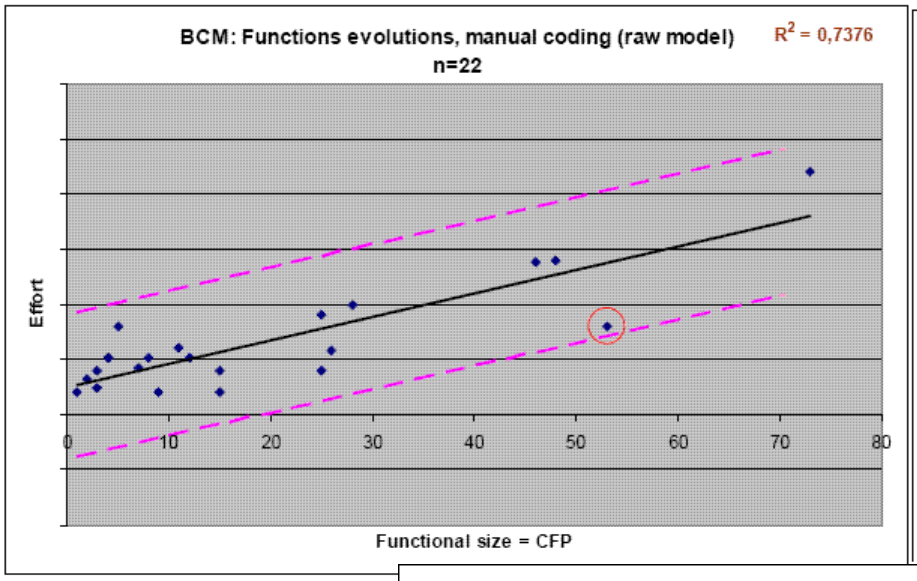
First results

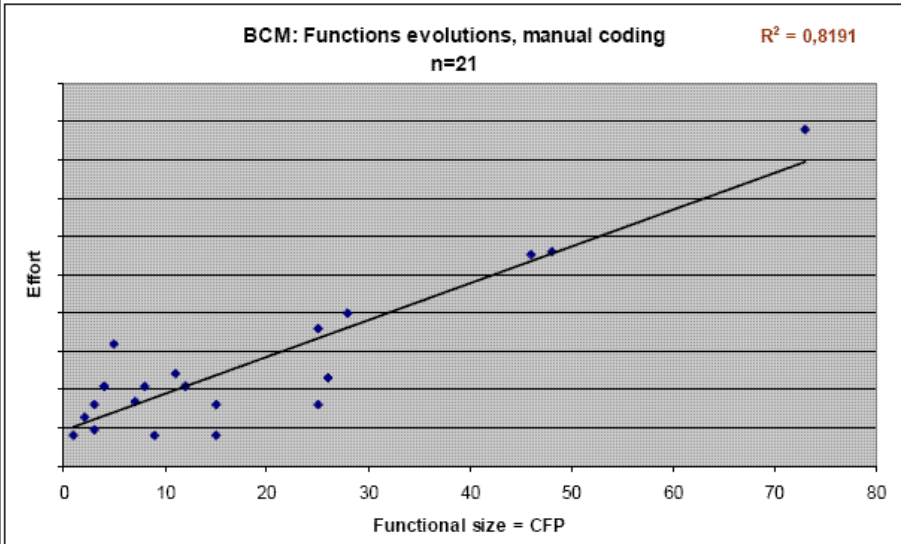
- ✓ IFPUG UFP values always higher than COSMIC CFP
- ✓ COSMIC seemed to have a best fit with embedded software projects
- ✓ Easier counting rules with COSMIC
- ✓ As a consequence – COSMIC used for a larger experimentation for embedded software projects
- ✓ The BCM (Body Control Module), with Statemate tool + textual requirements

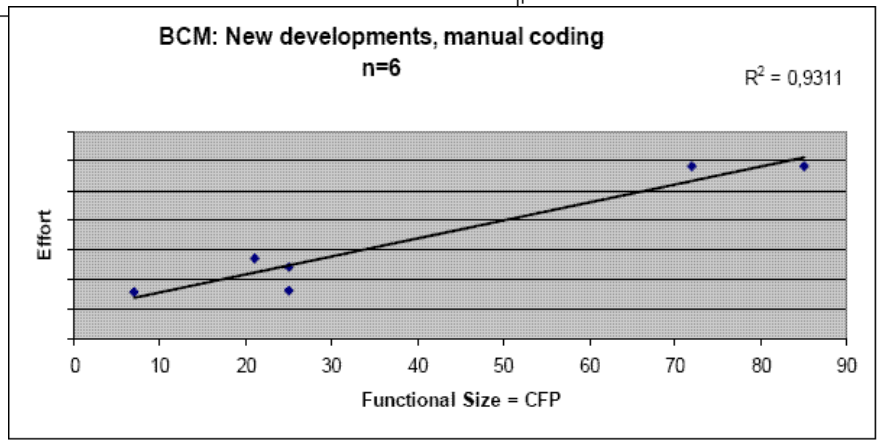
Four goals

- ✓ To have indicators for managing suppliers productivity during time
- ✓ To predict software function development costs for better negotiating with suppliers
- ✓ To be able to estimate a function software development cost as soon as specifications are written and choose if implement or not such function
- ✓ To benchmark productivity levels among different suppliers

Source: S.Stern, *Practical Experimentation with the COSMIC method in Automotive Embedded Software Field*, in IWSM-Mensura 2009 Proceedings, Amsterdam (Netherlands), November 2009







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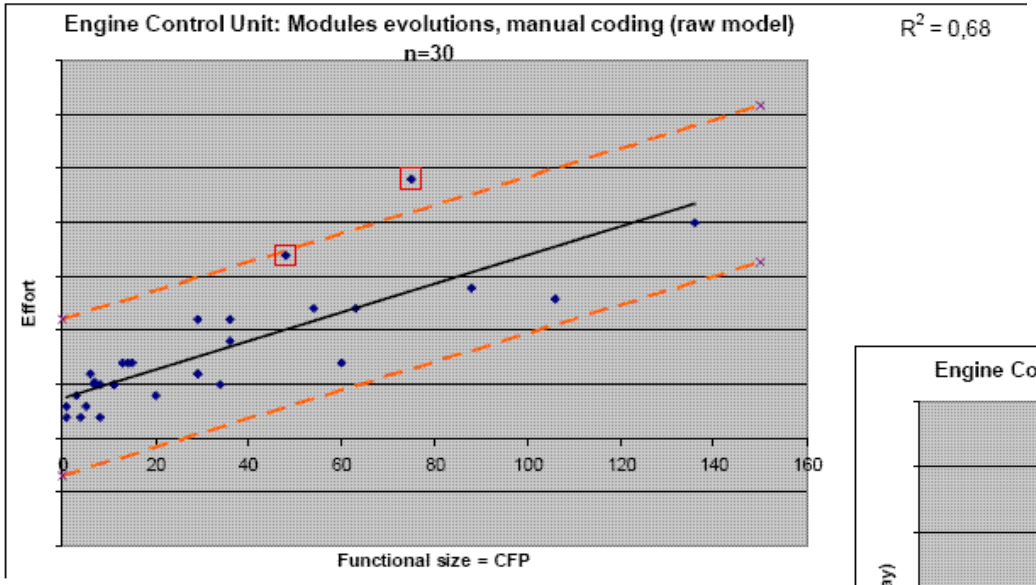

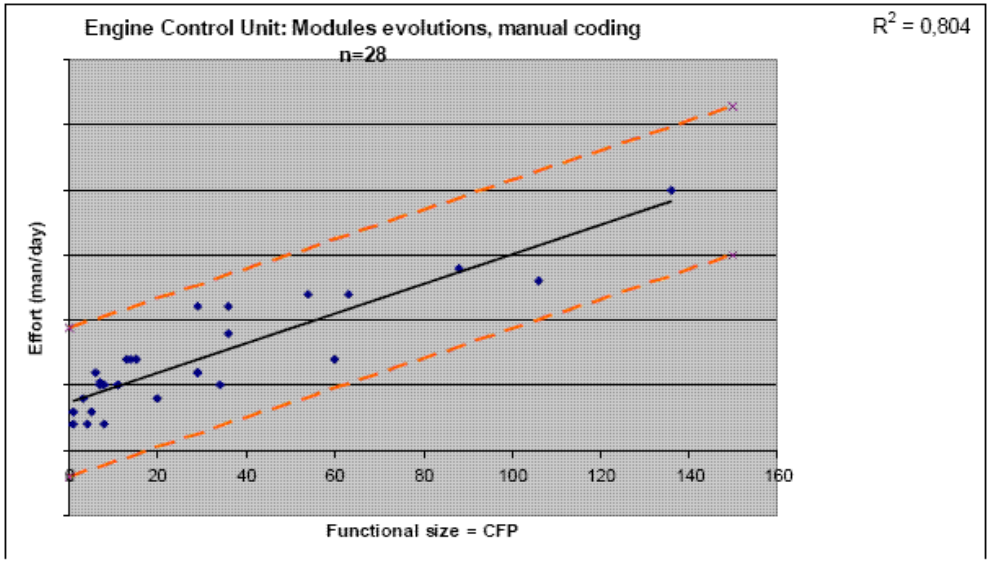

Source: S.Stern, *Practical Experimentation with the COSMIC method in Automotive Embedded Software Field*, in IWSM-Mensura 2009 Proceedings, Amsterdam (Netherlands), November 2009

- **FSM Methods**
  - ✓ Born with the goal to provide more objectivity in sizing FUR for a software system
  - ✓ The IFPUG method moved from the initial Albrecht's study and is nowadays the most diffused one after 30+ years (from 1979, when it was firstly presented)
  - ✓ 2 generations of FSMM (with/without weighting systems; single-multi layer, etc.)
  - ✓ Nowadays 5 FSMM are ISO/IEC standards, based on ISO 14143-x family
  - ✓ Intrinsic characteristic: *fsu* measure the software product, not its project and only for its functional side
- **COSMIC**
  - ✓ Method born in 1997 with the goal to complement the IFPUG one for real-time projects, become a per-se method during the years, as a further option against other FSMM
  - ✓ No weighting system, it counts only the frequencies of the 4data movements
  - ✓ Good approximation when converting with other FSMM
  - ✓ Worldwide diffusion on-going
- **Sizing & Estimation issues**
  - ✓ Each FSMM measures the product, not the project → assumptions in estimates about NFR
  - ✓ Complement the non-functional side for deployment
  - ✓ Make distinction between 'nominal' and 'functional' productivity
  - ✓ Cost/fsu: deal it with great care! → need for a clear definition of cost elements and its nature
  - ✓ Continual (technical) benchmarking, based on BFC

Thanks for your attention!
Grazie per la vostra attenzione!

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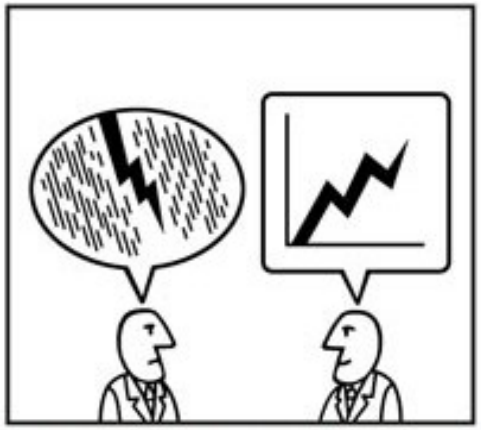

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Luigi Buglione

Industria, Servizi e Infrastrutture

Via R.Morandi 32
00148 Roma

Tel. +39-06.8307.4472
Fax +39-06.8307.4200
Cell. +39-335.1214813

www.eng.it

luigi.buglione@eng.it