An Overview of the COSMIC FFP
Field Trial Results

Alain Abran, Serge Oligny (Universite de Quebec a Montreal).
Charles Symons (Software Measurement Services)

ESCOM Conference, London, April 2001

© COSMIC Core Team 2000
Agenda

• Introduction to the COSMIC method

• Field Trials
  – Aims and participation
  – General Findings
  – Measurement results

• Conclusions
Existing methods of measuring the Functional Size of software have reached their limits

- Albrecht -> IFPUG 4.1
- Refinements: Feature Points, MkII FPA, 3-D FP, etc

✓ Widely accepted in Business/MIS software domain

✗ Tried and mostly rejected for ‘real-time’ software (e.g. telecoms, embedded, process control, operating systems)
✗ The attempt to account for technical and quality requirements via a ‘Value Adjustment Factor’ is clearly no longer valid
The COSMIC FFP Project Aims

To develop, test, bring to market and gain acceptance as an industry standard, a new generation of software functional sizing methods which are applicable:

• in as wide a range of software ‘domains’ as possible; priority to be given to business and real-time software (e.g. process control, operating systems, telephony, embedded, etc.)

• for performance measurement

• as a component of estimating methods from early in a software item’s life
Evolution of COSMIC FFP

- FP V1 Experience
- V2 Aims - COSMIC
- V2 Principles
- V2 Field Trials
- Research
- Tools, etc
- Prepare market acceptance
- Promotion

1998 1999 2000 2001

Today

On-going

On-going

On-going

On-going
COSMIC FFP Core Team: a broad range of academic and practitioner experience

<table>
<thead>
<tr>
<th>Name</th>
<th>Country</th>
<th>Experience:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alain Abran</td>
<td>Canada</td>
<td>Academia</td>
</tr>
<tr>
<td>Charles Symons</td>
<td>UK</td>
<td>IFPUG, MkII,</td>
</tr>
<tr>
<td>Moritsugu Araki</td>
<td>Japan</td>
<td>Laturi, NESMA,</td>
</tr>
<tr>
<td>J.-M. Desharnais, Serge Oligny, Denis St Pierre</td>
<td>Canada</td>
<td>etc</td>
</tr>
<tr>
<td>Reiner Dumke, Gunter Buehren</td>
<td>Germany</td>
<td>ISO SC7/WG12</td>
</tr>
<tr>
<td>Peter Fagg, Grant Rule</td>
<td>UK</td>
<td></td>
</tr>
<tr>
<td>Vinh Ho</td>
<td>Vietnam</td>
<td></td>
</tr>
<tr>
<td>Roberto Meli</td>
<td>Italy</td>
<td></td>
</tr>
<tr>
<td>Pam Morris</td>
<td>Australia</td>
<td></td>
</tr>
<tr>
<td>Jolijn Onvlee</td>
<td>Netherlands</td>
<td></td>
</tr>
<tr>
<td>Marie O’Neill</td>
<td>Ireland</td>
<td></td>
</tr>
<tr>
<td>Risto Nevalainen</td>
<td>Finland</td>
<td></td>
</tr>
</tbody>
</table>
The ‘Functional Size’ of software

- ISO/IEC/JTC1/SC7 Standard #14143 definition:

  “**Functional Size**: A size of software derived by quantifying the functional user requirements”

  “**User**: Any person, physical device, item of software, etc which interacts with the software being measured”
A general model of software FURs

Functionality = Data movements and Data manipulations
The User view of software FUR components

Users

OR

Engineered devices

OR

other Software

Boundary

DATA IN ('ENTRY')

Software

STORE PERSISTENT DATA ('WRITE')

DATA MANIPULATION OR TRANSFORMATION

RETRIEVE PERSISTENT DATA ('READ')

DATA OUT ('EXIT')
The COSMIC FFP model of software FURs

Software

Functional Process type

Data Movement type

Sub-process types

... only. As a reasonable approximation each data movement is assumed to have an associated constant average amount of data manipulation

Functionality = Data movements + some processing
Definition of a ‘Functional Process’

A functional process is a **unique set** of data movements (Entry, Exit, Read, Write)

It is **triggered** by a unique **event-type** and, once performed, must **leave the software in a coherent state** with respect to the triggering event

(Equivalent to MkII “Logical transaction” and similar to an IFPUG “Elementary process”.)
Definitions of ‘Data Movement’ and ‘Data Group’

• A Data Movement moves data belonging to a single Data Group

• A Data Group is a set of data attributes where each included data attribute describes a complementary aspect of the same, single Object of interest

‘Object’ is a synonym of ‘Entity-type’ – DO NOT confuse with ‘Objects’ of OO methods!
The **Size** of a Functional Process

- Convention for Unit of Measure
  
  \[1 \text{ Data Movement} = 1 \text{ COSMIC functional size unit (Cfsu)}\]

- The size of a Functional Process is the arithmetic sum of the number of Data Movements (Entries, Exits, Writes and Reads)

- The size of an item of software is the sum of the sizes of all the Functional Processes
A Functional Process to ‘Create’ a new employee

**Event:** the arrival of a new employee in the world of the User

1 x Entry (new employee data)

1 x Write (make employee data persistent)

1 x Exit (error and/or confirmation message)

**Total Size of the Functional Process:** 3 Cfsu’s
Functional Process: simple Real-time Example

A Functional Process to control temperature at regular intervals

**Event:** the tick of the real-time clock

1 x Entry (clock-tick)
1 x Entry (current temperature)
1 x Read (target temperature)
1 x Exit (on/off command to heater)

**Total Size of the Functional Process:** 4 x Cfsu’s
Overview of the measurement process

Define Purpose and Scope

- Gather artifacts of software to be measured

MAPPING PHASE 1

- Software FURs in COSMIC model

MEASUREMENT PHASE 2

- Functional size of software FURs
Summary: the full set of concepts of the COSMIC FFP model

Degree of Relationship:
- One-to-many
- One-to-one

* = Normally one-to-one

COSMIC-FFP Base Functional Component

Software Environment

Event (-Type)

User (-Type)

Functional Process (= Transaction-Type)

Software Item

Layer

Functional Sub-Process (= Data Movement-Type)

Input

Entry (-Type)

Write (-Type)

Read (-Type)

Exit (-Type)

Output

Data Attribute (Type) (is one of)

Data Group (Type)

Object (= Entity-Type)

Degree of Relationship:

Movements: (Moves)
Agenda

• Introduction to the COSMIC method

• **Field Trials**
  – Aims and participation
  – General Findings
  – Measurement results

• Conclusions
The Field Trial aims:

• to test for a common, repeatable interpretation of the Measurement Manual (under widely-varying conditions: organisations, domains, development methods, etc).

• to establish the detailed procedures, where necessary to ensure repeatable interpretation

• to test:
  - that the measures properly represent functionality
  - and/or correlate with development effort

• to enable a full transfer of technology to the trial ‘Partners’
Data collection completed in a formal context:
  – European aerospace manufacturer
  – European Bank (MIS systems)
  – Two European telecommunications manufacturers
  – Australian defence software contractor

+ Other data from:
  – Australian defence contractor
  – Australian real-time software house
  – Australian aerospace manufacturer
  – Canadian small software house
  – Canadian defence contractor
  – Canadian energy transportation organisation
Agenda

• Introduction to the COSMIC method

• Field Trials
  – Aims and participation
  – General Findings
  – Measurement results

• Conclusions
Some initial conclusions from applying the COSMIC FFP method

Can the method be applied equally to MIS and real-time software?
YES  It is easy to interpret the model in both domains
(Cf IFPUG. Classifying Elementary Processes as Inputs, Outputs or Inquiries is OK for MIS, but not for real-time software)

Are the four DM Types all of equal weight?
On very limited evidence - YES

Are the DMs on average the same size in MIS and real-time software?
We do not know yet.
Therefore, productivity comparisons across MIS and real-time software using COSMIC FFP must still be treated with caution
Tests showed good Repeatability in the right circumstances

• Test 1: avionics software documented to a high standard; engineers familiar with the domain -> near-perfect repeatability
• Test 2: process control software; senior engineers with domain experience -> good repeatability; junior engineers with limited experience of the domain and of functional sizing -> poor repeatability
• Conclusion: conditions for good repeatability
  – Experience of the domain and of the COSMIC FFP method
  – Local rules for unambiguous interpretation of local documentation standards using the COSMIC FFP method
Conventional FPA was designed to size the human view of business application software.

Conventional IFPUG and MkII FPA: the human view of functional size is identical to the developer’s view.

With two-tier Client-Server software, conventional FPA can measure the human view of size and can be stretched to measure the separate sizes of the client and server components.
The COSMIC method is much more flexible in the sizes it can measure than conventional FP methods.

The COSMIC method can be used to size the human view and also the size of the components of multi-tier, multi-layer software which the developer must build.
The general feedback is very positive

- ‘Project Teams were able to grasp the elements of the method easily and were enthusiastic about the method’

- ‘Documentation and effort needed is similar to that for applying the IFPUG method, though there is an extra step to identify layers’

- ‘The Z-unit has now also continued COSMIC FFP measurements with new projects and decided to implement this measurement technique as a standard procedure in their development process ’ (European participant).
Agenda

- Introduction to the COSMIC method
- **Field Trials**
  - Aims and participation
  - General Findings
  - Measurement results
- Conclusions
Field Trial projects used a variety of technologies

Set A of Development projects:

18 projects from 5 organisations:

– 16 New Developments & 2 Enhancements
– Platforms: 7 PC, 4 DEC, 2 HP, 2 IBM mf and 1 Compaq
– Completed between March 1999 and May 2000
– Duration: from 5 to 75 months
Specify effort per unit size is quite variable; Enhancements need less effort.

![Graph showing the relationship between software size (Cfsu) and effort (staff hours)].
Build effort per unit size is generally much more consistent.
Test effort/unit size is also quite variable
Speed of Delivery is also quite consistent

\[
\text{Delivery\_rate} = 0,5287(\text{Size})^{0,6212} \\
R^2 = 0,8213
\]

Software Size (Cfsu)

Delivery Rate (Cfsu/elapsed month)
The performance measurement results give confidence in the measurement methods.

Considering the variety of application types (telecoms, avionics, defence, MIS), technologies, organisations, there is a high degree of consistency of the performance measurements.
Agenda

• Introduction to the COSMIC method

• Field Trials
  – Aims and participation
  – General Findings
  – Measurement results

• Conclusions
The COSMIC FFP method is a big advance over existing Functional Sizing methods

<table>
<thead>
<tr>
<th></th>
<th>IFPUG FPA</th>
<th>MkII FPA</th>
<th>COSMIC FFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usable for MIS applications?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Usable for real-time applications &amp; infrastructure software?</td>
<td>No</td>
<td>Not easily</td>
<td>Yes</td>
</tr>
<tr>
<td>Accuracy for MIS</td>
<td>Questionable</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Ease of use</td>
<td>Complicated</td>
<td>Slightly complex</td>
<td>Simple</td>
</tr>
<tr>
<td>Compatible with modern requirements analysis methods?</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Benchmark data?</td>
<td>Yes</td>
<td>Yes</td>
<td>Starting</td>
</tr>
<tr>
<td>International acceptance?</td>
<td>Yes</td>
<td>Growing from UK base</td>
<td>Growing from International base</td>
</tr>
</tbody>
</table>
The COSMIC FFP method is much more valuable than just for sizing

We need requirements which are

- Understandable
- Traceable
- Testable
- **Measurable**

The COSMIC FFP method is a basic requirements analysis method – size measurement is almost a spin-off
COSMIC FFP method has achieved a number of ‘firsts’

The first Functional Sizing method to:

– be designed by an international group of experts on a sound theoretical basis

– draw on the practical experience of all the main existing FP methods

– be designed to conform to ISO 14143 Part 1

– be designed to work across MIS and real-time domains, for software in any layer or peer item

– be widely tested in field trials before being finalised
Available resources

- **Complete documentation** on the Web
  - Concepts and definitions,
  - Measurement Manual,
  - Publications,
  - http://www.lrgl.uqam.ca/ffp.html
  - http://www.cosmicon.com

- **Training and consultancy** support available in Europe, N America and Asia/Pacific