Measurement Convertibility - From Function Points to COSMIC-FFP

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Abstract

Several organizations are interested in using convertibility ratios between COSMIC- FFP (ISO 19761), the second generation of functional size of the software, and Function Points Analysis – FPA (ISO 20926). This paper presents a survey of previous convertibility studies and reports on findings from an additional data set. In summary, these studies indicate that convertibility can be simple and straightforward when only human users are taken into account in the measurement viewpoint. It also provides indication that convertibility can be less straightforward is some instances.

1. Introduction

Since the late 70s, function points have been used as a measure of software size to calculate project productivity and project estimates. Even though a large number of variants of the Function Point Analysis (FPA) method have been proposed over the years to tackle some weaknesses in the design of the original FPA method, only four methods have finally achieved recognition as ISO measurement standards:

- ISO 19761: COSMIC-FFP [ISO 03a].
- ISO 20926: Function Point Analysis (e.g. IFPUG 4.1, unadjusted function points only) [ISO 03b];
- ISO 20968: Mk II [ISO 02]
-ISO 24570: NESMA [ISO 05]

NESMA [ISO 05] is a Dutch interpretation of FPA version 4.1 which produces similar results [NESM04]. The FPA, MarkII and NESMA methods were primarily designed to measure business application software. COSMIC-FFP, the newest method, was designed to handle other types of software as well, such as real-time, telecommunications and infrastructure software (Figure 1).

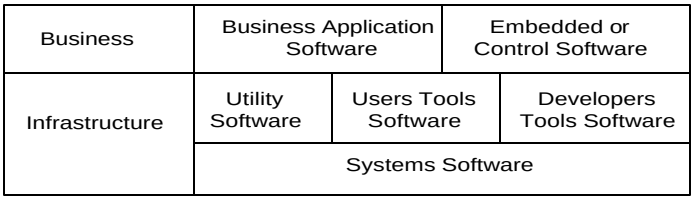

Figure 1 Software Types [9]

Organizations interested in converting to the newest COSMIC-FFP measurement method have expressed interest in a convertibility ratio that would allow them to leverage their investments in historical data measured with FPA. The goal of this paper is to provide industry with insights into this issue of convertibility between FPA and COSMIC-FFP. The convertibility studies reported here have been carried out with duplicate measurements using both COSMIC-FFP and FPA (or NESMA equivalent) on the same set of functional user requirements (FURs). The specific versions of methods used in each convertibility study are documented for each study.

In this paper, the results of the convertibility study from the COSMIC field trials [ABRA00, DESH00] are not included: version 1.0 of FFP (Full Function Points) was used in that study, and, since major changes to the measurement rules were introduced between version 1.0 and 2.0, results from this earlier study are not relevant for our purposes, which is convertibility with current versions of these ISO standards.

The following pre-conditions exist in all studies reported here:

- All functionalities inside the boundary of the software being measured are included in the measurement.
- Measurements have been taken from the human user viewpoint.

- FPA is considered not to include the value adjustment factor (VAF), in conformity with ISO 14143-1 [ISO98] and ISO 20926, that is, unadjusted function points (UFP).

Data from both the Fetcke 1999 study and the Vogelezang and Letherthuis 2004 study were included in the discussion on convertibility in the 'COSMIC Implementation Guide to ISO 19761' [9, chapter 8]. They are discussed as individual data sets in this study.

This paper is organized as follows: an analysis of the Fetcke study is presented in section 2, of the Vogelezang and Lethertuis study in section 3 and of the Desharnais 2005 data set in section 4. A discussion is presented in section 5.

2. Fetcke 1999

Context

In the Fetcke 1999 study [FETC99], four software applications of a data storage system were measured. These are business applications with few data entities; all four applications handle three entities or fewer, and these entities are all referred to in the elementary processes being measured by the FPA method. In this Fetcke study, all details of the measurement process are reported for both methods [FETC99]. It is to be noted that, while the Fetcke study used version 2.0 of COSMIC-FFP, the results reported are valid for the current version of COSMIC-FFP (2.2), the changes not having impacted the related rules applied in the Fetcke study.

Measurement results

The results of the duplicate measurements of the four software applications are reported in the first two columns of Table 1: column (1) contains the FPA measurements in UFP unit, and column (2) the COSMIC-FFP measurements in Cfsu units. The measurement results for both methods are presented next graphically in Figure 2, with the FPA data on the x-axis and the COSMIC data on the y-axis. In this study, the FPA size range is limited (between 40 and 77), the software being measured being similar, this makes this the sample fairly homogeneous.

Software	FPA (1)	COSMIC-FFP (2)	With convertibility formula in Cfsu (3)	Convertibility Delta (4) = (3) – (2)	% Delta (5) = (4)/(2)
Warehouse	77	81	79	-2	2%
Large Warehouse Customer Business	56	52	56	4	8%
Customer Management	49	51	48	-3	6%
Manufacturer's Warehouse	40	38	38	0	0%

Table 1: Fetcke Data Set [1]

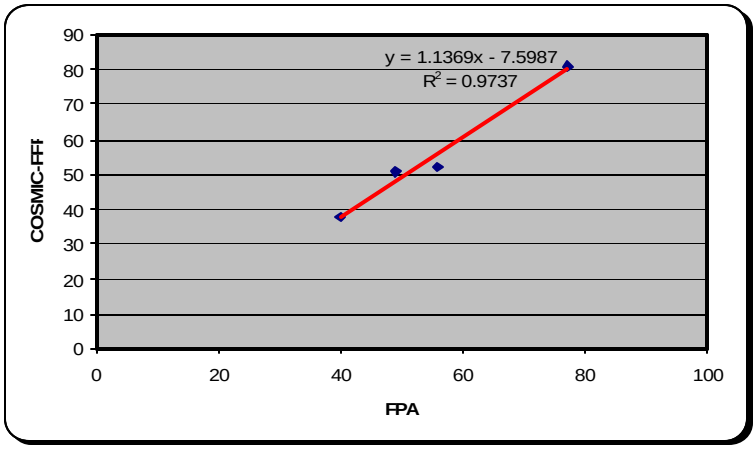

Figure 2: Fetcke Data graph

Analysis and interpretation

The linear regression model of the data in Figure 2 provides the following convertibility formula, where 'Cfsu' represents COSMIC-FFP functional size units and 'UFP' represents unadjusted function points, with a very high coefficient of determination (R^2) of 0.97:

$$\mathbf{Y(Cfsu) = 1.1 * (UFP) - 7.6} \qquad \mathbf{(1)}$$

The constant in the regression model represents the error term, Of course, the number of data points being small (that is only four in the data set), care must be exercised in the extrapolation of these results to larger data sets, and to data sets from different contexts.

The application of the convertibility formula to the FPA data is reported in column (3), and the delta between the data from the convertibility formula and the COSMIC-FFP data from measurement is reported in absolute numbers in column (4) and in % in column (5). For this data set, column (5) indicates that there is little variation (0% to 8%) between the number of converted COSMIC-FFP units (column 3) and the duplicate COSMIC-FFP measurements (column 2).

In summary, the duplicate measurement of software containing few data files and from the human end-user viewpoint gave very similar results and a convertibility formula with a slope fairly close to 1.

3. Vogelezang & Leterthuis 2003

Context

In the Vogelezang & Leterthuis 2004 study [VOGE03a], the COSMIC-FFP measurements were carried out by SOGETI on 11 projects already measured with the NESMA FPA (ISO 24570) at the Rabobank financial services organization. An earlier version of this dataset had previously been reported in [DEKK03] with fewer data points.

Measurement results

The results of the duplicate measurements of the four applications are reported in Table 2 – columns (1) and (2). These data points are also presented graphically in Figure 3a, with the NESMA data on the x-axis and the COSMIC data on the y-axis.

Software	NESMA (1)	COSMIC-FFP (2)	With convertibility formula in Cfsu (3)	Convertibility Delta (4) = (3) – (2)	% Delta (5) = (4)/(2)
1	39	23	-40	-63	-274%
2	52	29	-25	-54	-186%
3	120	115	57	-58	-50%
4	170	109	117	8	8%
5	218	181	135	46	25%
6	224	182	182	0	0%
7	249	173	212	39	23%
8	260	81	226	145	179%
9	380	368	369	1	0%
10	766	810	832	22	1%
11	1 424	1662	1613	53	3%

Table 2a : Vogelezang & Leterthuis Data Set [6]

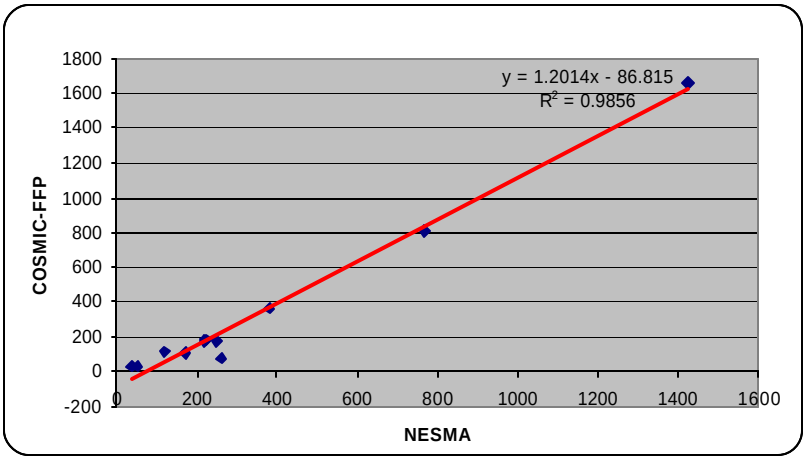

Figure 3a: Vogelezang & Leterthuis 2003 data graph

Analysis and interpretation

The linear regression model of the data in Figure 3a provides the following convertibility formula, with a coefficient of determination (R^2) of 0.99:

Y(Cfsu) = 1.2 * (UFP) - 87 **(2)**

Vogelezang and Lesterhuis postulate that constant 87 probably owes its existence to the counting of the logical files of data ILFs and EIFs in FPA [VOGE04], which are not directly included in COSMIC-FFP; this interpretation indicate that the high value of 87 might not be due entirely to the error term alone in this model.

With this specific data set, the two largest projects have significant influence on the regression model: it can therefore be observed that the conversion formula does not work well for small projects with less than 200 NESMA points, providing even negative numbers, which is not possible in practice. This means that, for small projects in this environment, distinct regression models should be built using only data within a relatively similar range. For instance, this data set could be split into two ranges: from 39 to 170 UFP (Table 2b and figure 3b), and from 218 to 1 424 UFP (Table 2c and figure 3c).

Software	NESMA (1)	COSMIC-FFP (2)	With convertibility formula in Cfsu (3)	Convertibility Delta (4) = (3) – (2)	% Delta (5) = (4)/(2)
1	39	23	27	4	16%
2	52	29	36	7	26%
3	120	115	88	-27	-24%
4	170	109	125	16	15%

Table 2b : Vogelezang & Leterthuis – Less than 200 NESMA points

Software	NESMA (1)	COSMIC-FFP (2)	With convertibility formula in Cfsu (3)	Convertibility Delta (4) = (3) – (2)	% Delta (5) = (4)/(2)
5	218	181	138	-43	-24%
6	224	182	145	-37	-20%
7	249	173	176	3	2%
8	260	81	190	109	134%
9	380	368	337	-31	-8%
10	766	810	811	1	0%
11	1 424	1662	1620	-42	-3%

Table 2c : Vogelezang & Leterthuis – Greater than 200 NESMA points

The linear regression model of the data in Figure 3b for projects with less than 200 NESMA points provides the following convertibility formula, with a coefficient of determination (R^2) of 0,85:

Y(Cfsu) = 0.75 * (UFP) - 2.6 (3)

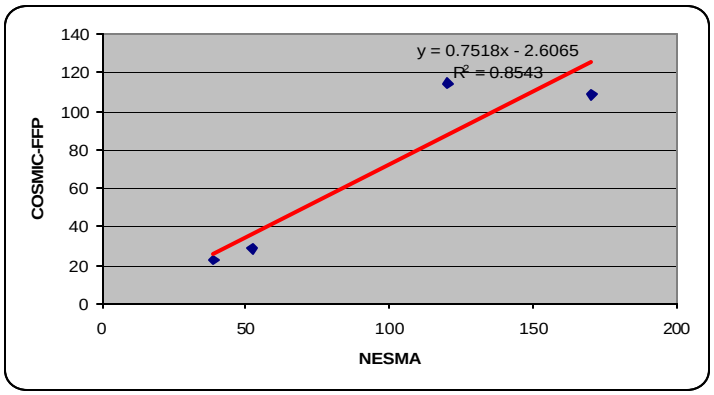

Figure 3b **Vogelezang & Leterthuis data graph (less than 200 NESMA points)**

Convertibility formula from equation (3) with a slope of 0.75 and a much smaller error term of -2.6 is more relevant for representing small size projects in this data set: this formula lead to much smaller convertibility delta, both in absolute and relative terms (columns 4 and 5 of table 2b compared to corresponding column in table 2a for the same projects).

Next, the linear regression model of the data in Figure 3c for projects greater than 200 NESMA points provides the following convertibility formula, with a coefficient of determination (R^2) of 0,99:

Y(Cfsu) = 1.2 * (UFP) - 108 (4)

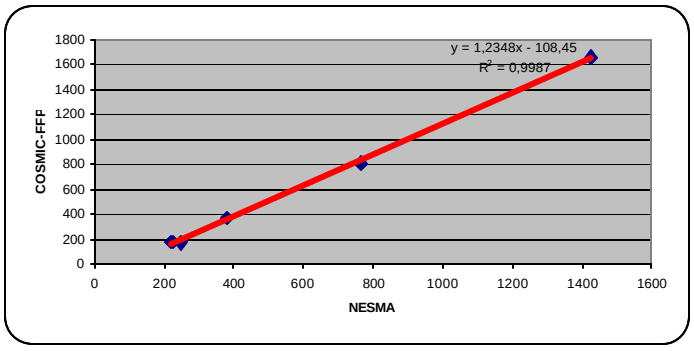

Figure 3c **Vogelezang & Leterthuis data graph (more than 200 NESMA points)**

The models for the full data set and for the data set of projects over 200 NESMA points are fairly similar in terms of both their slope and error terms. There is still however a large difference in convertibility results for project number 8 at 260 NESMA points, both in absolute and relative terms. This means that there must be some peculiarities in the way that functionality is measured that leads to non straightforward convertibility.

4. Desharnais 2005

Context

The duplicate measurement results reported next were collected in 2005 by one of the authors (Desharnais) using FPA 4.1 and COSMIC-FP 2.2. This data set comes from one governmental organization and was measured using the documentation of completed projects.

Measurement results
The measurement results of the duplicate measurement of the four applications are reported in Table 3a. These data points are also presented graphically in Figure 4a, with the FPA data on the x-axis and the COSMIC data on the y-axis.

Analysis and interpretation
The linear regression model of the data in Figure 4 provides the following convertibility formula, with a coefficient of determination (R^2) of 0.91:

Y(Cfsu) = 0.84 * (UFP) + 18 **(3a)**

Again, there is a large difference in convertibility results for project number 2 at 362 FPA points, both in absolute and relative terms. This means again that there must be some peculiarities in the way that functionality is measured that leads to non straightforward convertibility.

Software	FPA (1)	COSMIC 2.2 (2)	With convertibility formula (3)	Convertibility Delta (4) = (3) – (2)	% Delta (5) = (4)/(2)
1	103	75	105	30	39%
2	362	209	322	113	54%
3	124	170	122	-48	-28%
4	263	203	239	36	18%
5	1146	934	981	47	5%
6	570	675	497	-178	-26%

Table 3a : Desharnais 2005 Data set

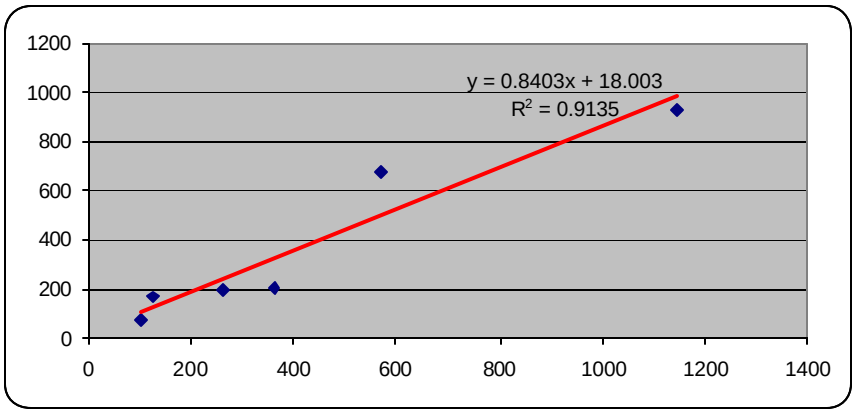

Figure 4a : Desharnais 2005 Data graph

In the FPA measurement method, the data is taken into account from multiple perspectives, once as logical data files (ILF – Internal logical file and EIF – External interface file) and once again whenever that are references in FPA transactions (Input, Output, Enquiries transaction types).This has already been noted in [VOGE03a] where it is reported that in FPA-like methods 30 to 40% of functional size comes from the data files. By taking into account only the FPA data files points from the FPA transaction types points, it is investigated next whether a better convertibility ratio could be derived by excluding the FPA data files, that is by taking only the NESMA points coming from the transactions (TX) only

The FPA points for the transactions only are presented in Table 3b, and the linear regression model of the data in Figure 4b which provides the following convertibility formula, with a coefficient of determination (R^2) of 0,98:

Y(Cfsu) = 1,35 * (UFP) + 5.5 **(3b)**

There is then a slight improvement in the (R^2) for the convertibility formula when using only the results of the transactions for FPA instead of the total number of points that include both data and transactions; again, with such a small data set, this should be taken as indicative only and should be investigated with larger data sets.
It can be observed that while the convertibility results of project 2 have improved in terms of converging to the correct COSMIC size, this convergence has decreased for project 3. Not enough information about the detailed measurement is available for investigating such convertibility behaviour.

Software	FPA TX (1)	COSMIC-FFP (2)	With convertibility formula in Cfsu (3)	Convertibility Delta (4) = (3) – (2)	% Delta (5) = (4)/(2)
1	60	75	87	12	16%
2	196	209	271	62	29%
3	60	170	87	-83	-49%
4	179	203	248	45	22%
5	688	934	936	2	0%
6	468	675	638	-37	-5%

Table 3a : Desharnais 2005 Data – Transactions size only

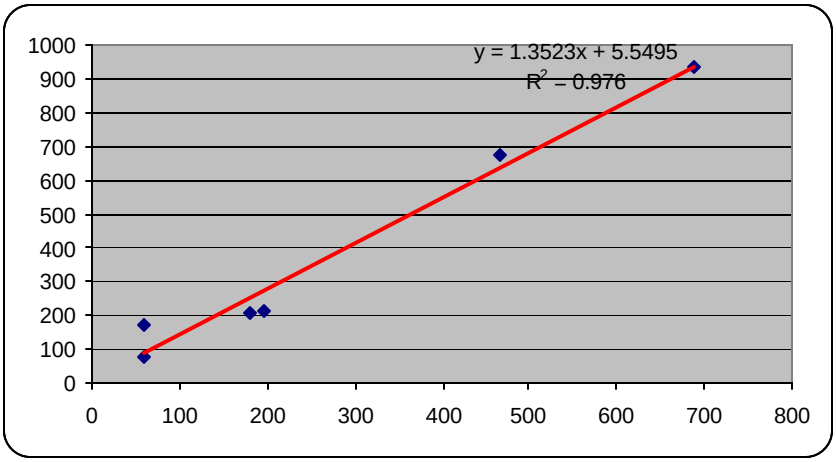

Figure 4b : Desharnais 2005 Data graph - – Transactions size only

5. Discussion

This paper has presented a convertibility analysis from Function Points to COSMIC-FFP for three data sets. In all the reported data sets, measurements were taken from the human user viewpoint, that is taking into account the functionality of the software interacting with a human, and the measured applications were all business software applications.

In summary, these analyses indicate that a relatively simple convertibility formula can be obtained for each data set, and that there is some variations in the convertibility formulas across organizations: in summary, these analysis have not come up with a unique conversion formula and the convertibility formula will vary across organizations. This variation across organizations could be caused by various extraneous factors, such as non homogeneity of software types across the organizations where the measurements were derived.

These analyses also provide indication that convertibility can be fairly accurate for the majority of the projects within a data set but, on the other hand, there are some larger variations for a few projects. This means that convertibility of a full portfolio could be reasonably accurate overall, but that some individual projects would show some larger dispersion from the values predicted by the convertibility models. Further research is required to investigate factors that could explain such larger individual projects variations.

This study has not investigated more complex contexts, such as for projects with more complex processes and/or when there are software users other than software or engineered devices, as in real-time software. Under these latter conditions, of course, backward convertibility (from COSMIC-FFP to FPA) is not such of interest nor an issue since such functionality related to non-human users (such as interactions with sensors or controllers in embedded software, or in multi-layered software) would not usually have been taken into account in first generation measurement methods.

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