Basic Measurement Implementation: away with the Crystal Ball

Ton Dekkers
Sogeti Nederland B.V.
ton.dekkers@sogeti.nl

Abstract

When implementing FPA, COSMIC Full Function Points or another measurement program everyone is looking for best practices. Although there is a change in initiation of a measurement program the items relevant for an implementation did not really change. In the early days IT (supplier) initiated most of the time the measurement program. Nowadays business management (principal) shows more interest in having a measurement program in place. But it has to be controllable and transparent. Business is not looking for a crystal ball. With that the measurement program should be pragmatic, simple and give quick wins. Because implementations are part of the business of Sogeti Nederland B.V., we developed based on over 10 years of experience a model that addresses strategical, tactical and operational issues. MOUSE gives a helping hand for both experienced and less experienced professionals to do a successful implementation.

1. Introduction

An information system intends to support the business objectives. The way in which such a system will be designed and constructed has been standardized by the maturing field of software engineering. In practice most development will be organized in some form of project and go through a number of stages. By distinguishing the relevant stages a project can be divided into well-defined activities with matching milestones. In this way the development process is controllable and manageable.

Every metrics professional is aware of the value metrics have in decision making. With a trained eye metrics can be seen everywhere [1]: many software developers use some kind of metric to establish the quality of the requirements or to establish whether produced code is ready to be tested. Effective project managers have metrics that allow them to tell when the software will be ready for delivery and whether the budget will be exceeded. In projects metrics are usually used implicitly. To convince decision makers in IT-environments that those metrics need to be used explicit and in an unambiguous way is often still a difficult job. Despite significant progress implementing a successful metrics program for software development is still a challenging undertaking [2].

2. Implementing a metrics program

2.1. Setting the scope

Just like an information system, a method, a technique, a tool or an approach is supporting the achievement of an objective. Following this line of thought, implementing a method, a technique and so on, should in many ways be comparable to the development of an information system. It doesn't matter where a metrics program is positioned; implementing a metrics program can be seen as 'just another' staged project. To some extent this is a valid comparison. But since a metrics program is

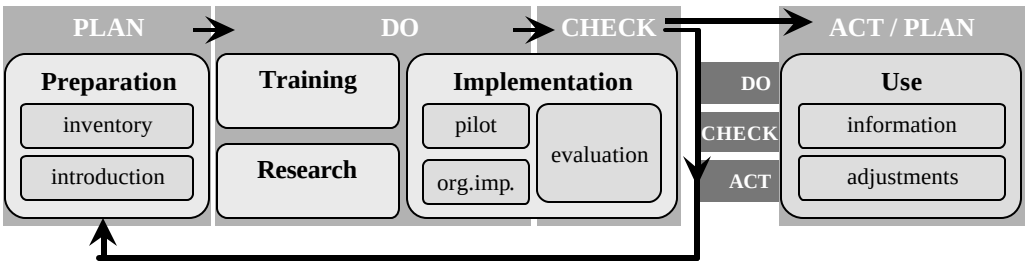


Figure 1, the project baseline

really not the same as an information system it requires different activities. Also the stages are somewhat different.

Before the decision to implement a metrics program is made, goals need to be defined clearly that should be served by the program [3]. A good framework to decide which metrics are needed for the defined goals is the GQM-method [4]. Metrics can be used for various purposes. These goals and corresponding timeframes are the basis for the organization specific elements in the implementation of a metrics program. In figure 1, the baseline for the project lifecycle with the names of the metric program implementation is given and in the following paragraph each stage is explained in detail.

2.2. Preparation

As showed in figure 1 the preparation phase has two main activities: inventory and introduction. This phase can be compared with the feasibility study: the requirement has to be drawn up and presented to the stakeholders.

During this stage an *inventory* is drawn up of the current working methods and procedures are recorded together with all aspects that might have a relation with the metrics program to be implemented, such as:

- already implemented measurements;
- software development methodology (staging, milestones, activities, products, guidelines and standards);
- software development environment;
- which project characteristics are general organization characteristics and which characteristics are project specific;
- the way effort is recorded;
- risk management.

After the analysis of the current situation, the results have to map on the objectives of the measurement program. The future situation and the "design" of the metrics program will have to be established. Now can be determined which stakeholders in which role will be affected by the metrics program. Those stakeholders have to be *informed* and when necessary trained to work with the metrics program.

At the end of the preparation stage there is a documented consensus about what the metrics program is expected to monitor, who will be involved and in what way (implementation plan vs. project plan)

2.3. Training

Employees in the organization who are affected by the metrics program will have to be trained to use the metrics properly. Depending on the role this training can range from an introductory presentation to a multiple day training course. For the introduction of a metrics program in an IT-organization typically five categories of employees emerge:

- Management
  The management must have and convey commitment to the implementation of a metrics program. The management needs to be informed about the possibilities and impossibilities of the metrics program. They also must be aware of the possible consequences a metrics program can have on the organization. It is well known that employees feel threatened by the introduction of a metrics program and in some cases react quite hostile. Such feelings can usually be prevented by open and correct communication of the management about the true purposes of the metrics program.
- Metrics analysts:
  The employees who are responsible for analyzing and reporting about the metrics data. They are also responsible for measuring and improving the quality of the metrics program itself. Usually they

are already involved in the preparation stage and do not need any more training in this stage of the metrics program.

- Metrics collectioners:
  The employees that are actively involved in collecting or calculating the metrics have to know all the details and consequences of the metrics, to assure correct and consistent data. If the metrics that are used in the metrics program come from activities that are already common practice, the training may only take several hours. If the metrics are not common practice or involve specialist training, for instance if functional sizes have to be derived from design documents, the training may take a substantial amount of time. In the last case this involves serious planning, especially in matrix organizations: It will not only consume time of the employee involved, but it will also affect his or her other activities.
- Software developers:
  Usually a lot of the employees that are involved in the software development will be affected, directly or indirectly, by the metrics program, because they 'produce' the information the metrics program uses. They need to have understanding of the metrics and the corresponding vocabulary. For them the emphasis of the training needs to be on understanding the use and importance of a metrics program for the organization, because they are usually not experiencing any benefit from it in their personal activities, but may need to change some of their products to make measurement possible or consistent.
- End-users or clients:
  Although a metrics program is set up primarily for the use of the implementing organization, end-users or clients can also benefit from it. In particular sizing metrics are useful in the communication between the client and the supplier: how much will the client get for its money. Whether this audience will be part of the training stage for a metrics program depends on the openness of the implementing organization: are they willing to share information about the performance of their projects?

At the end of the training stage everyone who will be affected directly or indirectly by the metrics program has sufficient knowledge about this program. It may seem obvious, but it is essential the training stage is finished before (but preferably not too long before) the actual implementation of the metrics program starts.

2.4. Research

In this stage the metrics to be implemented are mapped on the activities within the organization that will have to supply the metrics data. The exact process of collecting the metrics data is determined and described so that at the start of the implementation it is unambiguous how the metrics data are collected.

In this stage it is useful to determine what the range of the metrics data might be. A useful concept for this is planguage [5]. A wrong perception of the possible result of metrics data can kill a metrics program at the start. It is also important to establish at least an idea of the expected bandwidth of the metrics data beforehand to know what deviations can be considered acceptable and what deviations call for immediate action.

At the end of the research stage all procedures to collect metrics data are described, target values for each metric are known and allowable bandwidths are established for each metric in the metrics program.

2.5. Implementation

Unless an organization is very confident that a metrics program will work properly from the start, it is best to start the implementation with a pilot. In a *pilot* metrics are collected from a limited number of

activities. In a pilot all procedures are checked, experience is built up with these procedures and the first metrics data are recorded. In this way the assumptions about the metrics values and bandwidths from the research stage can be validated.

After the completion of the pilot all procedures and assumptions are *evaluated* and modified if necessary. When the modifications are substantial it may be necessary to test them in another pilot before the final organizational implementation of the metrics program can start.

The pilot and its evaluation can be considered the technical implementation of the metrics program. After completion of this stage the metrics program is technically ready to be implemented. Until now the metrics program has had little impact on the organization, because only a limited number of employees have been involved in the pilot. The *organizational implementation* of a metrics program will have an impact on the organization because the organization has formulated goals which the metrics program will monitor. These goals may not have been communicated before or may not have been explicitly made visible. Metrics will have to be collected at specified moments or about specified products or processes. This could mean a change in procedures. For the employees involved this is a change process, which can trigger resisting or even quite hostile reactions. Over 10 years of experience show that the most suitable organizational structure for a metrics program is to concentrate expertise, knowledge and responsibilities in an independent body. An independent body has many advantages over other organizational structures. For example, when activities are assigned to individuals in projects, many additional measures have to be taken to control the quality of the measurements, the continuation of the measurement activities and the retention of expertise about the metrics program. When responsibilities for (parts of) the metrics program are assigned to projects, additional enforcing measures have to be taken to guarantee adequate attention from the project to metrics program assignments over other project activities. Installing an independent body to oversee and/or carry out the metrics program is essential for achieving the goals the metrics program was set up for. This independent body can be either a person or a group within or outside the organization. How this body should operate is laid down in the MOUSE concept, which will be described in detail later on.

At the end of the implementation stage the metrics program is fully operational and available throughout the organization.

2.6. Use

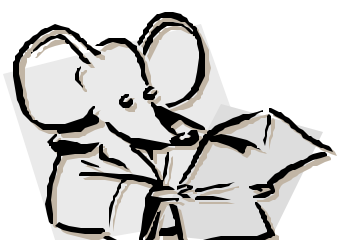
This stage is actually not a stage anymore. The metrics program has been implemented and is now a part of the day-by-day operations. The metrics program is carried out conform the way it is defined and is producing *information* that helps the organization to keep track of the way it is moving towards their goals.

A mature metrics program gives continuous insight in the effectiveness of current working procedures to reach the organizational goals. If the effectiveness is lower than desirable *adjustments* to the procedures should be made. The metrics program itself can then be used to track if the adjustments result in the expected improvement. If working procedures change it is also possible that adjustments have to be made to the metrics program.

Organizational goals tend to change over time. A mature metrics program contains regular checks to validate if it is still delivering useful metrics in relation to the organizational goals. All these aspects are covered in the MOUSE concept [6].

3. MOUSE

3.1. Key Issues



Implementing a metrics program is more than just training people and defining the use of metrics. All the lessons learned from organizations like Rabobank formed the basis for MOUSE, a concept to help to set-up the right implementation and to create the environment the method fits in [7]. MOUSE describes all activities and services that need to be carried out to get a metrics program up and running.

The MOUSE concepts contains all activities and services required to implement a metrics program successfully and lasting, clustering the activities and services into groups of key issues, described in the table below:

Market view	**O**peration	**U**tilisation	**S**ervice	**E**xploitation
Communication	Application	Training	Helpdesk	Registration
Evaluation	Review	Procedures	Guidelines	Control
Improvement	Analysis	Organisation	Information	
Investigation	Advice		Promotion	

Table 1: Key issues of the MOUSE concept

In the next paragraphs the five key issues of the MOUSE concept will be explained, in some cases illustrated with examples of the implementation within an IT department of Rabobank Nederland.

3.2. Market view

Communication in the MOUSE concept is an exchange of information about the metrics program both internally (the own organization) and externally (metrics organizations). Internal communication is essential to keep up the awareness about the goals for which the metrics program is set up. For example: The Rabobank uses company publications and an intranet website to share information.

Communication with metrics organizations is important to stay informed about the latest developments. Usually an important metric in a metrics program in an IT-environment is the functional size of software The International Function Point User Group (IFPUG) and local organizations like Netherlands Software Measurement Association (NESMA) and the Australian ASMA are the platforms for Function Point Analysis [8]. COSMIC and NESMA (workgroup COSMIC) are platforms for COSMIC Full Function Points [9]. The implementation" of these issues depends on the organizational situation. Rabobank outsourced metrics experts to Sogeti. Because Sogeti has various connections with these organizations, the Rabobank will be informed about developments through Sogeti and does not need to implement specific activities to keep up-to-date.

If the independent body is located within the client's organization (Rabobank, outsourcing in-house), a direct and open communication is possible with stakeholders of the metrics program to *evaluate* whether the metrics program is still supporting the goal it was set up for. When the independent body is positioned outside the client's organization more formal ways to exchange information about the metrics program may be desirable (another bank in the Netherlands, outsourcing only size measurement, "offshore"). Regular evaluations or some other form of assessment of the measurement process works well for an open communication about the metrics program.

The signals that the evaluations provide are direct input for continuous *improvement* of the metrics program. Depending upon the type of signal (operational, conceptual or managerial) further investigation may be required before a signal can be translated to measurement process improvement.

Investigation can be both theoretical and empirical. Theoretical investigation consists of studying literature, visiting seminars or following workshops. Empirical investigation consists of evaluating selected tools for measurement and the analysis of experience data. Usually these two ways of investigation are used in combination. Sogeti carries out investigations for proprietary purposes. Results are passed on to client organizations as a service by Sogeti's Expertise Centre Metrics. An example of this kind of investigation is the research of early sizing techniques for COSMIC-FFP [10].

3.3. Operation

Application includes all activities that are directly related to the application of the metrics program. This includes activities like executing measurements (for example functional size measurements, tallying hours spent and identifying project variables). Within the MOUSE concept the client can choose to assign the functional sizing part of the operation either to the independent body or to members of the projects in the scope of the metrics program.

The best way to guarantee quality of the measurement data is to incorporate *review* steps into the metrics program. The purpose of reviewing is threefold:

- ensure correct use of the metrics (rules and concepts);
- keep track of applicability of the metrics program;
- to stay informed about developments in the organization that might influence the metrics program.

During the research stage all procedures to collect metrics data are described for each metric in the metrics program. These procedures are usually described in a way that they support the organizational goal for which the metrics program was set up. Some metrics data can also be used to support project purposes. The independent body can then be used to give advice about the use of the metrics for these purposes. For example an aspect of the metrics program can be the measurement of the scope creep of projects during their lifetime. Functional size is measured in various stages of the project to keep track of the size as the project is progressing. These functional size measures can also be used for checking the budget as a second opinion to the budget based on work breakdown structure for example. The independent body can give *advice* about the translation of the creep ratio in the functional size to a possible increase of the budget.

During the research stage target values and allowable bandwidth are established for each metric in the metrics program. The independent body will have to *analyze* if these target values were realistic at the beginning of the metrics program and if they are still realistic at present. One of the organizational goals might be to get improving values for certain metrics. In that case, the target values for those metrics and/or their allowable bandwidth will change over time.

3.4. Utilization

Next to the basic *training* at the start of a metrics program it is necessary to maintain knowledge about the metrics program at an appropriate level. The personnel of the independent body should have refreshment training on a regular basis, referring to new developments (rules, regulations) in the area of the applied methods. The independent body can then decide whether it is necessary to train or inform other people involved in the metrics program about these developments. In the case that the independent body is outsourced, the supplier can be made responsible for keeping the knowledge up-to-date.

To guarantee the correct use of a method, *procedures* related to measurement activities of the metrics program are necessary. They are usually initiated and established in the research stage of the implementation. Not only the measurement activities themselves need to be described, but also facilitating processes like:

- project management;
- change management control;
- project registration;
- (project) evaluation.

After the initial description in the research stage the independent body should monitor that that all the relevant descriptions are kept up-to-date.

As stated earlier the independent body can reside within or outside the *organization* where the metrics program is carried out. The decision about this organizational aspect is usually combined with the number of people involved in the metrics program. If the metrics program is small enough to be carried out by one person in part-time the tasks of the independent body are usually assigned to an external supplier. If the metrics program is large enough to engage one or more persons full-time the tasks of the independent body are usually assigned to employees of the organization. Depending on the type of organization this might not always be the best solution for a metrics program. When the goals the organization wants to achieve are of such a nature that it involves sensitive information, calling in external consultants might be a bad option, no matter how small the metrics program might be. If employees have to be trained to carry out the tasks of the independent body, they might perceive that as narrowing their options for a career within the organization. In that case it might be wise to assign these tasks to an external party specializing in these kinds of assignments, no matter how large the metrics program is. Outsourcing these assignments to an external party has another advantage: it simplifies the processes within the client's organization. Another advantage of outsourcing the independent body could be political: to have a really independent body to do the measurement or at least a counter measurement.

3.5. Service

To support the metrics program a *helpdesk* needs to be instated. All questions regarding the metrics program should be directed to this helpdesk. The helpdesk should be able to answer questions with limited impact immediately and should be able to find the answers to more difficult questions within a reasonable timeframe. It is essential that the helpdesk reacts adequately to all kinds of requests related to the metrics program. In most cases the employees that staff the independent body constitute the helpdesk.

Decisions made regarding the applicability of a specific metric in the metrics program need to be recorded in order to incorporate such decisions into the 'corporate memory' and to be able to verify the validity of these decisions at a later date. Usually such decisions are documented in organization specific *guidelines* for the use of that specific metric.

The success of a metrics program depends on the quality of the collected data. It is important that those who supply the data are prepared to provide this data. The best way to stimulate this is to give them *information* about the data in the form of analyses. This should provide answers to frequently asked questions, such as: "What is the current productivity rate for this specific platform?", "What is the reliability of the estimations?", "What is the effect of team size?". For questions related to functional size metrics the experience database can usually answer most of those questions. If this is not (yet) available experience databases of third parties can be used, e.g. the ISBSG Benchmark [11].

Promotion is the result of a proactive attitude of the independent body. The independent body should market the benefits of the metrics program and should 'sell' the services it can provide based on the collected metrics. Promotion is necessary for the continuation and extension of the metrics program.

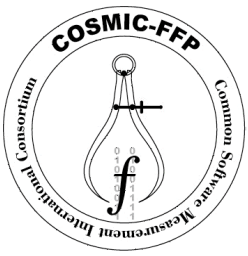
3.6. Exploitation

The *registration* part of a metrics program consists of two components: the measurement results and the analysis results. In a metrics program in an IT-environment all metrics will be filed digitally without discussion. Here a proper registration usually deals with keeping the necessary data available and accessible for future analysis. For most metrics programs it is desirable that the analysis data is stored in some form of an experience database. It this way the results of the analyses can be used to inform or advice people in the organization.

Control procedures are required to keep procedures, guidelines and the like up-to-date. If they do no longer serve the metrics program or the goals the organization wants to achieve, they should be adjusted or discarded. Special attention needs to be given to the procedures for storing metrics data. That data should be available for as long as is necessary for the metrics program. This might be longer than the life of individual projects, so it is usually advisable to store data in a place that is independent of the projects the data comes from.

4. MOUSE in Practice

4.1. Implementation Plan



The IT department of Rabobank Nederland felt the need for an additional measurement method because FPA used at that time did not fulfill the needs. Due to contacts with external organizations (MOUSE - Market View - Communication [M1]) Rabobank got interested in COSMIC Full Function Points (CFFP), which is designed to be applicable for classical developed business applications, applications developed with contemporary methods, real-time software and infrastructure software. The method comprises possibilities to measure component development, multi-layer architecture and interfacing with hardware. All technical conditions of the bank seemed to be fulfilled with CFFP [7]. When the management responsible for the measurement activities gave permission to implement CFFP, the measurement group was asked to draw up a plan for the migration to an Expertise Centre Metrics (ECM) and the implementation of CFFP. The plan should pay attention to the level of measurement (viewpoints), scalability, productivity rates and impact on the organization (ECM and customers of ECM). The plan was set with MOUSE in mind.

The table shows the scheduled activities in detail, the estimated time, the real effort, the reference to MOUSE and some Learning Points (LP).

	Activity		Real	MOUSE	Remarks
1	Planning & Control				
1.01	Implementation Plan		40	M4	
1.02	Project control		96	-	LP1
2	Preparation				
2.01	Extend evaluation with CFFP		4	M2, U2	
2.02	Change document Regression analysis		-	O3, U2, E1	LP2
2.03	Change Configuration Items		35	U2, U3, E2	LP3
2.04	Decision Viewpoints, change guidelines and procedures		287	M2, M3, U2, S2	LP4

2.05	Create summary CFFP		-	M1	LP4
2.06	Change web-site ECM		19	M1, S3, S4	
2.07	Create reference measurement CFFP		-	O1, O2, S2	LP4
2.08	Adapt PROBE for CFFP		-	A3, U2, E1, E2	LP2
2.09	Create intake criteria CFFP		-	U2	LP4
2.10	Create guideline viewpoints		-	U2, S2	LP4
2.11	Draw up conditions system specifications		-	U2, S2	LP4
2.12	Pilot: 3 small applications		138	A1, A2	8 applications
2.13	Pilot: 3 average applications		25	A1, A2	1 application
2.14	Pilot: 3 big application		48	A1, A2	1 application
2.15	Regression Analysis		131	A3	LP2
2.16	Configure SIESTA [12]		0	U3, E2	Sogeti
2.17	Prepare presentations		8	M1, S3, S4	

3	Implementation				
3.01	Presentation to Division Mgt		2	M1, S3, S4	LP5
3.02	Presentation to Project Mgt		2	M1, S3, S4	LP5
3.03	Transformation to ECM / CFFP		2	M4, U3, S3	LP5
4	Closing				
4.01	Support QA department		-	S1	LP4
4.02	Clean-up and file documents		-	E1	LP4
4.03	Closing Report		0	-	No interest
	TOTAL HOURS		837		

Table 2: Planned / Actual Implementation CFFP

A good reader has seen that some MOUSE issues are missing in the table. They are correct. Missing are O3, O4 and U1. Analysis (O3) and Advice (O4) will not be different from what they did with FPA. Because the Rabobank has outsourced this expertise and Sogeti already trained several metrics specialists (including the persons working in Rabobank) in CFFP in this plan training (U1) was not necessary.

4.2. Learning Points:

- Project Control
  The most important participant in the transformation was an analyst from Sogeti trained in CFFP. He was new in the team, so it took some additional time to become familiar with the procedures in place. Time spent was booked on project control (overhead costs). Because of additional effort on analysis (see LP2), project control required more time as well.
- (Regression) Analysis
  The new analyst had a mathematical background. To gain benefits from the FPA investments in the past, management asked him to investigate whether there is a possibility to reuse the measurements done in the past. The strategy was to resize 10 projects with CFFP that were previously sized with FPA, instead of using new projects in the pilot. The next step was to analyze this data statistically. The aim was to find a possible conversion factor between function points (fp) and cosmic functional size units (cfsu). The time spent for analysis is booked under analysis. The outcome of the statistical analysis was input for PROBE, the estimation tool (excel) developed by the ECM.
- Configuration items
  Most configurations already existed, only time was needed to change documentation and name conventions.
- Transformation
  This was the real underestimated activity. It was more difficult for experienced FP analysts to learn to apply CFFP. The analysts tried to apply CFFP with FPA rules in their mind. Because of the different approach to data (groups) CFFP requires a different mind-set. This is the most important lesson learned and this has to be taken into account for future transformations.
- Information
  To project managers it does not matter whether they get function point or cosmic functional size units. Both represent size and the measurement concept is still applicable. The estimation process does not change, only the values of some variables change. The information they needed was just the highlights of CFFP and that was all.

5. Conclusions

Performing the activities involved in a metrics program will cost effort and thus time. Starting a metric program is one thing, surviving is another thing. When implementing a metrics based on

MOUSE a number of critical success factors are taken care of. The metrics program is set up to service the organization efficient and effective and what's what more important provide added value to the organization not only at the start but continuously updating the services to the changing demands. Metrics should develop according to the development of the organization, use MOUSE to organise it be keep the program flexible. A metrics program is controllable and transparent, no crystal ball.

6. About the author

Ton Dekkers is working as a practitioner, manager and consultant within the area of software metrics and software quality for a great number of years. Within this area he specialises in estimation, performance measurement, risk analysis, priority management and QMap (Quality Management approach). He is a regular speaker both at national and international conferences and a trainer in software estimation, risk management and Quality Tailor-Made (QTM – QMap in practise).

Ton Dekkers is senior project consultant of the division Managed Delivery of Sogeti Nederland B.V. He is responsible for the Expertise Centre Metrics and R & D in the area of estimating & performance measurement.

In the metrics area he is involved in COSMIC Full Function Points (member International Advisory Committee of COSMIC, chair Working Group CFFP of Netherlands Software Metrics Association), Function Point Analysis (Board Member NESMA, chair WG New technology) and Software Benchmarking (Vice-President of International Software Benchmarking Standards Group).

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