Function Points as Product Units

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Abstract. *Software maintenance has a series of peculiarities when compared to software development. This article describes a successful case of solving strategic and tactical management issues regarding planning and control of COTS software using function points as a product unit. Among those issues, the most critical are: managing scheduling software product change requests from the client base thru a time-boxed scenario where four releases are made within a one year time period; improve quality and productivity; decrease of overhead time of development and test departments. Measurement and Analysis process area description was used as a road map and the critical improvements were achieved by means of defining and implementing: Management milestones to track progress dissociated of software engineering disciplines; the standard work package as management unit for planning department's demands; the reengineering of the Development Department, segregating activities measured by production from those measured by availability.*

1- Client Organization

LG Sistemas is a software company with a nationwide presence providing a full HR Systems Suite, leader in its segment it operates for 25 years in the Brazilian market. Figure 1 shows the components of this Suite.

Figure 1 – Suite of products of LG Sistemas

The Suite's users are the main clients of the LG's Planning Department. The demands received from those clients are kept as electronic documents also known as "LGin". Planning Department groups and arranges them as input in order to elaborate the Product Plan defining which demands will be addressed in which version. Four new versions are released on a yearly basis. One of the Planning Department's challenges is to adjust the scope and the work load for each version to the Development Department's software production capacity within the

respective time period. The Development Department has as client the Planning Department for the purpose of this paper.

The Development Department is responsible for the constant update of the Suite (it is the main responsible for the software production). It responds to the Services Executive that operates as the controller in the software productive process. Internally to the Development Department, it defines work packages called Technical Service Request (SA), which are just meaningful to the technical staff. As a whole, the complete set of those units defines a technical plan of action towards the new version in terms of the work decomposition regarding the different Software Engineering disciplines.

2- History

The first contact between the authors' company (FATTO) and LG Sistemas took place in 2004, when 8 professionals from the Development Department participated in a Function Points Analysis training session followed by a three day mentoring; totaling one workweek.

The client organization's further initiative to the use of function point as a software product unit by itself has not yielded the expected results by 2006, when there was a new engagement pointing out: a) Difficulty in FPA implementation; b) Issues raised about FP, as defined by IFPUG, to be the best software product unit for scope measurement in the client organization; c) Internal political trends in search of other means to measure software production.

This new engagement starts a joint initiative, yet quite limited in scope, to assess the highlighted items. In that occasion, it was identified: a) Labor utilization (staff-hours) for the version deployment is not accrued; b) The functional size is just estimated, never measured; c) There is too much variation between estimated time to complete and actual progress in each individual demand (the demand management unit is the "LGin" at that time).

When Function Point Analysis is used in a scenario where the function point is like a currency unit within a contract, to implement Function Points as a software product unit is much simpler than in a scenario where there is an employer and employee relationship. It is so because there isn't just a well defined interface between "who produces" and "who plans and evaluates the production", but all internal aspects to the productive process are also visible in the perspective of who performs this second role. Another aspect that should be considered is the nature of the work, pulverized in the treatment of various maintenance demands in contrast to large development projects.

Using as input the discoveries pointed out by this second engagement, the client organization moves forward with the improvement work by itself and undertakes some ventures like the establishment of Project Office and the quest for CMMi® certification.

By 2009, the client organization and FATTO started a third engagement. In this occasion, the scenario presented a much greater maturity in terms of process definition and infrastructure management. This paper describes the joint initiative to establish a software product unit for software planning and production control spawning over a period of one year.

3- Implementing Function Point as Product Units

Since the last two short term expert consulting engagements with the client organization have not achieved the desired results, the intent in this third opportunity is to use a more collaborative approach and a broader scope in terms of process and organization redesign. The author proposed and the Services Executive decided to use CMMi®, specifically the

measurement and analysis process area, as a roadmap in this initiative and this paper is organized following the same principle.

The work strategy was to propose and define changes in order to align measurement and analysis practices with the Services Executive objectives. Before performing any formal process update about **the** proposed change, as soon as it was settled among those entrusted to implement it, it was put in motion in an iterative approach for the process improvement where the concepts could be tested and refined in the current version. References like COCOMOII and RUP were used for an "economic view" of software production.

3.1- Identify the measurement objectives

Concurrently to the beginning of this initiative, the Organizational and Process Restructuring (ROP) occurs with the support of the Instituto de Desenvolvimento Gerencial – INDG. So, the measurement objectives necessary to align the analysis measurement process with the business objectives are already defined. They are: a) Measure the current productivity in the Suite evolution; b) Establish goals to improve productivity; and c) Monitor the production evolution over time.

3.2– Establishing measures

When it comes to productivity, it is necessary to take into perspective that it is defined as the quantity of goods or services produced per unit of labor or expense. From the measurement goals above, two basic measures rise: a) Function Point to measure goods; and b) staff-hours to measure the labor.

Some difficulties are already visible. They have been there for a long time and probably contributed for the client organization not been fully successful in past initiatives. They are:

- An internal focus when assessing the productivity; a perspective of those who will have the productivity evaluated: The management unit type used is the Technical Services Request (SA) generated by the Development Department, considering its software configuration management constrains and the division of labor;

- Available FP counts are not correct: The Planning Department lacks the technical capacity to count, validate or contest the delivered Development Department's counts; fundamental skills to the measurement goals to be achieved. The APF technique was designed for professionals who aren't from the IT to be able to apply it through due training. The actual business functions in itself is measured, not the technological artifacts that implement business functions;

- There is no quantitative management of scope: Although they use function points count making allowance for effort estimation, the interaction between the Development Department and its customers is made by the assumption of a series of commitments of time, effort and cost. The scope is defined in terms of LGin included in the version, but there is no effective quantification.

- There is no scope development tracking performed by project management in terms of its increasing detail and refinement during the life cycle evolution: Reference information of time, cost and effort are kept related to the original plan; however, new intermediary estimates baselines are neither made nor kept for future analysis of deviation. In summary, only one reference is maintained while it should have an appropriate reference for each phase of the life cycle;

- There are no management phases addressing version progress aligned to the Planning Department perspective: Internally to the Development Department, the phases are defined regarding each individual SA in terms of its progress thru each software engineering discipline, for example, the requirements phase ends as of the delivery of a SA's requirement specification. If the development strategy was in cascade, this model would be appropriate, however, the client organization uses an iterative and incremental strategy, where inception phase ends before all the requirement work is complete.

3.3- The introduction of the "Service Order"

It is necessary to elect a demand management unit type when FPA measures the production. It documents the demands' scope and progress by capturing measures and estimates of the goods delivered (count of development projects or improvement projects) and of the expenses employed in the scope delivery (work and time necessary to produce those goods).

A demand management unit must be created by the customers of whom productivity is to be managed; It should not be made internally to whom it is measured, the smaller the management unit is, greater the tendency to increase the goods score (there is a FP measuring rule that the same function never repeats itself in the scope of a single demand management unit).

During the initiative described in this study, were evaluated as potential demand management unit type:

- The Product Plan: Contains all improvement demands to the Suite scheduled to release in a specific version by the Planning Department;

- The Technical Services Request: Work packages as defined by the work breakdown structure of labor within the Development Department and the constraints related to product configuration management; and

- The "Row" in the Product Plan: Set of improvement demands from the Suite users grouped by the Planning Department as a unit – a "row" in the Product Plan. It is handled by the Planning Department as a cohesive work package and is identified by the number of the most important improvement demand to the Suite also known as "Father LGin".

The "Father LGin" was elected as the demand management unit and is now addressed as Service Order (SO). It is the smallest unit of work used for purposes of planning, monitoring and evaluation of the Development Department's productivity.

The other two potential demand management unit types are still being used for the purposes they were created for.

Each version has a fixed three-month term; however there are some Service Orders whose term surpasses this time span. Those will be treated as a separate, yet concurrent, project from the version. This condition may not always be foreseen; when it happens, the SO likewise will be treated as a separated project, being both its goods (function points) and its expenses (hours-staff) purged from the version.

The introduction of the SO requires project office attention to allow scope information (function points) and effort employment (staff-hours) to be captured and aggregated. In order to do so, it is also necessary to associate each SA to a respective SO.

3.4- The different work profiles: Purchase of production x availability

There are two different service profiles provided by the Development Department in a Planning Department's perspective: Deliver the development and improvement projects as defined by IFPUG, therefore, measureable in FPs; and provide support to the Suite in order to ensure its availability to the customers (availability of services levels).

It was not uncommon, the same professional to be responsible for both types of service. There was no specific support team dissociated from the project team. It wouldn't invalidate the initiative, but it would make harder the collection, processing and interpretation of key process indicators; in a similar way, it presented challenges to the production management by the Development Department as well.

The author recommends and the Services Executive decides to create under the Development Department a specialized team to deal just with support activities. It represented a great change in the productive process and introduced the management of two concurrent versions, each one at a different phase in some point in time.

3.5- Establishing of Management Planning and Tracking Phases

The life cycle phases represent the division of a software project into a well defined set of points where milestones defined by a set of delivered project products, which can be checked and/or validated regardless the full completion of a specific Software Engineering discipline. So, the COCOMOII's assumptions are references used as support to defining those points. The principle assumed is that the Management Planning and Tracking Phases should be defined so that the measurement is something intrinsic and natural to the productive process. At first, were planned the following phases:

ᏸᏗ   Scope

A contract is established between the Planning Department and the Development Department with the definition of a yet high level schedule for a three months term for the version.

This phase's milestone is the set of Service Orders that defines the version scope validated between the Planning Department and Development Department; each OS generates a first estimate spreadsheet of function point counting.

The goal for completion of this phase is two weeks before the end of the construction of the previous version.

ᏋᏗ   Technical Service Control Committee (CCA)

At this point, 80% of the Service Orders:

- Haves its requirements detailed;

- The business impact matrix refined;

- The proposed solution set;

- Remaining work hours estimated for each subject;

- Impact assessment through automated tools;

- Alignment with test analysts, business analyst, designers, requirements analyst and leader.

At this moment, a new measurement (yet an estimate) is also produced and registered in the Demands' Planning and Tracking System (SO).

♍②　　Delivery Version

The version is ready for release and the final measurement is performed; the Demands' Planning and Tracking System (SO) is updated as well. Figure 2 illustrates how the functional measurement data is captured according to the different Management Planning and Tracking Phases through the Demands' Planning and Tracking System (SO).

Figure 2 – Form for estimates and measurement records

3.6- Measurement Trainning

A critical success factor for the entire initiative described in this paper is the quantitative management of scope. Almost every professional within the involved departments passes thru more extensive Function Point Analysis training, as well as new counting workshops performed considering the new defined premises.

A team with representatives from both Planning Department and Development Department are part of the Measurement and Analysis Committee. Members of this Committee participate of the XIII FPA Week in Brasília.

3.7- The role of the Planning Department and External Auditing

The Planning Department is responsible for the initial estimates of the SO when defining the version's preliminary scope. It receives from the Development Department the productive capacity in terms of "FP_{scope}" to that version. One "FP_{scope}" is a currency worth more than one "$FP_{measured}$". The client organization maintains a baseline of measurement and estimates of functional size in the SO that allows it to have statistical data to support the planning.

After the refinement of estimates by the Development Department as it evolves thru the life cycle, the Planning Department is enabled to challenge and seek clarification from them after refinement of the requirements, estimates and the measurement.

Multiple SO's are subjected to external verification as a complement to the role of the Planning Department to avoid undue counts inflation. Additionally, the external audit complements the formal training received by those involved in the process.

4- Specify mechanisms for Data Collection and Storage Procedures

In particular, it was very useful that the initiative described here happens in a Software Enterprise. It is so because what is usually captured in electronics spreadsheets and stored in files systems might be more easily organized in automated computer systems.

The client organization develops a Demands' Planning and Tracking System (SO) centered on the Service Orders; the client organization's *Enterprise Project Management* solution (EPM solution) is customized so that there are baselines according to the Management Planning and Tracking Phases defined; the existing systems are enhanced in order to be able to trace requirements from SA, through SO, up to the "LGin".

4.1- Staff-Hour accrual

The data collection procedures are integrated to existing expedient (albeit adjusted) such as work accrual and schedule elaboration. The effort accrued on the EPM solution is compared against the payroll data and there is a small tolerance range for eventual deviation, with internal audit aiming to ensure compliance.

The work hours are treated as an expense of the Development Department, decreasing their productivity; otherwise, it must decrease the productivity of another department: Hence the critical role of its collection and storage.

4.2- Functional Measurement

The functional measurement data is stored in electronic spreadsheets and treated as configuration items of the version. It was not necessary to use a software tool at that moment. It's necessary to define whether it is better to develop or adapt any existing system to keep the inventory with the baseline count for the Suite software products. The spreadsheet with the application counts is maintained along with other inventory items such as user cases, user manuals and source code. These sheets are kept under the same version control used by other project artifacts and inventory of Suite software products.

5- Specify Analysis Procedures

In order to the measuring goals be achieved it is necessary when planning a next version, the Development Department to know beforehand its production capacity to be dedicated to it. Briefly, the process consists of:

♋①   Assess the number of the new version's workdays and the amount of employees to be engaged, in order to produce an amount of gross staff-hours.

♌①   Subtract hours unrelated to the version deployment from the resulting gross staff-hour giving a net staff-hours: i) support; ii) technological update projects unrelated to the version; iii) SOs which time-frame surpass the version time-frame; and iv) vacation and alike;

♍①   Based on the productivity goals (H/FP) and on the net staff-hours, determine the production capacity (in terms of FP);

♎①   During the production of the version, unforeseen demands may occur and new priorities set so that Service Orders not originally planned might be included as part of the

version. A percentage of the Development Department capacity is reserved for this purpose as a contingency.

♏ ②   The Development Department's productivity goal is defined from measurement data performed based on product delivery; at planning time there's no measurement, there are estimates. Therefore, it´s necessary to adjust this productive capacity to reflect this fact. For example, if the productive capacity to the version is defined in 1000 FP (measured), there will only be released to the Planning Department a capacity of 600 FP (estimated).

In this procedure, we have two keys indicators:

a) The productivity goal, reviewed when the version ends when a statistical analysis of the version takes place.

b) The relative error (%) between the Planning Department´s initial estimates, elaborated from a preliminary scope, to the final scope measured and consolidated when the version is delivered.

At the end of the interaction between the Development Department and Planning Department, the scope of the version if defined in terms of a set of Service Orders, the time for every new version is fixed ("time boxed").

Figure 3 illustrates with more details the information used in planning the version capacity.

LG SISTEMAS
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Data: 12/06/2010

Planilha de Planejamento de Versão - Desenvolvimento   **Versão:**

Dias úteis da versão		30,00 dias
Meta de Produtividade		10,00 hrs/pf
Total da equipe		52,50 pessoas
a) Colaborador 8 horas	40,00 pessoas	
b) Colaborador 6 horas	10,00 pessoas	
c) Colaborador 4 horas	10,00 pessoas	
(-) Dedução de pessoas		-14,00 pessoas
a) Gerente	1,00 pessoas	
b) Projetista Líder	1,00 pessoas	
c) Contratações pendentes	0,00 pessoas	
d) Equipe GBI	7,00 pessoas	
e) Equipe GMP4	5,00 pessoas	
(-) Emprestimos de Pessoas		-4,24 pessoas
a) SEPG	34,00 horas	
b) Teste de Software	100,00 horas	
c) Customização	23,00 horas	
d) SIPAT/CIPA	60,00 horas	
e) Cursos/Seminários	800,00 horas	
(-) Afastamento	100,00 horas	-0,42 pessoas
(-) Férias	200,00 horas	-0,83 pessoas
(-) Transversão		0,00 pessoas
Total de recurso na versão		33,01 pessoas
Total de horas na versão		7.923,00 horas
Capacidade máxima		792,30 pf
% de Contingência para imprevistos		5,00%
Capacidade contingenciada		752,69 pf
% de Erro de estimado para detalhado		50,00%
Capacidade contingenciada de erro		501,79 pf
Contigencia (reserva)		26,41 pf

Considerações referente o planejamento desta versão

Figure 3 – Sheet of Production Capacity Planning

From this contract, a system built on a BI platform, called "Panel", is fed with baseline information. The Development Manager monitor the progress of two concurrent versions using this "panel" to identify adjustments such as request of more demands to be included in the version or providing servicing to other customers aiming to achieve (or surpass) the productivity goal.

The operation of the "Panel" can be described as follows:

α) Version Team updates Demands' Planning and Tracking System (SO) with scope measurement data at the end of each Management Planning and Tracking Phase milestone: scope defined; CCA; final delivery.

β) Different levels of information are normalized by using MMER among the two estimates and the final measurement (scope, CCA or delivery)

χ) It enables the estimation at Completion (EAC) for the scope size (amount of function points) at any moment.

δ) Team registers SO work hours (Actuals-to-Date) and updates estimates (Estimate to Complete) in the EPM solution.

ε) These data are consolidated and showed by the "Panel" as the Estimation at Completion (EAC) of work directly appropriate in a Service Order.

φ) With the EAC of work (Hours-staff) and the scope (function points) we have a projection of the net productivity of the Development Department. It excludes accrued extra-projects activities (overhead);

γ) The extra-project Actuals-to-Date hours (data in EPM unrelated to a SO) follows the same logic: the Development Manager informs when consulting the Panel his Estimate to Complete of extra-project work. The sum of the two numbers is the EAC extra-project hours.

η) Relating the sum of the EAC project work and the EAC extra-project work with the EAC version scope, we have the gross productivity projection.

Figure 4 illustrates the monitoring screen provided by the "Panel" where the goods (Function Points) and expenses (Hours-staff) are listed in the monitoring of the productivity.
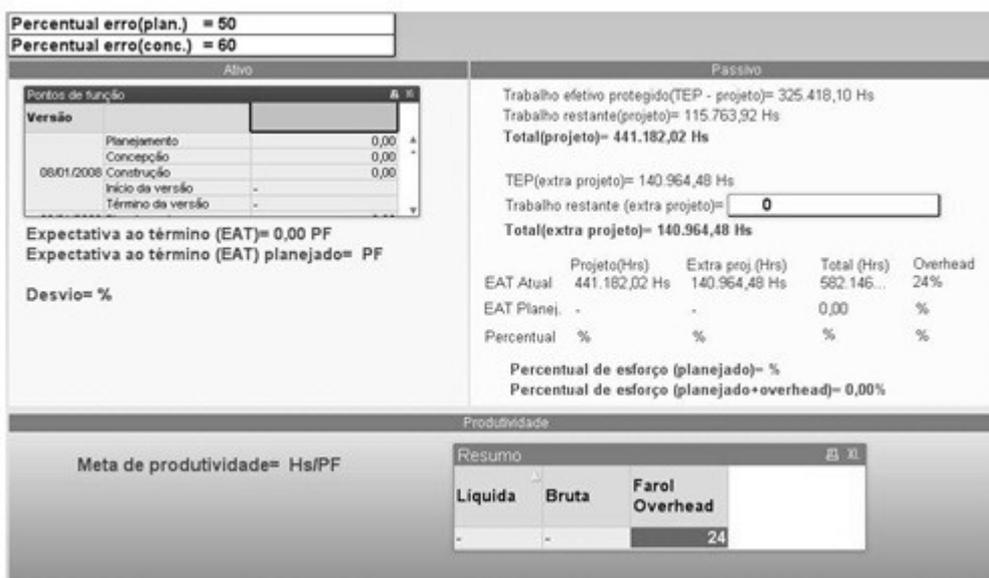

Figure 4 – Monitoring screen of the "Panel"

In the final version, these data are placed on a spreadsheet responsible for generating a report to evaluate the productivity with:

ã) Projection of the delivery rate (H/FP) is determined by using the Least Squares Method and a series of associated references: the coefficient of determination (R^2); the effort percentage (%) each department represents from the total (nowadays there is only the Development Department, the model is ready for new additions such as the Test Department); the magnitude of the relative error when applying the delivery rate projection and the actual achieved (the automation lets you to choose between MER, MRE and BRE as an input to calculate this average, the figure 5 example uses the BRE); the percentage of chance (Chance) of a smaller delivery rate to be verified in the sample used; Sum of error estimated subtracted from actual (E-A); The PRED (.25), a percentage expressing the number of services order that have an error of up to 25% using the delivery rate projection compared to the total number of Service Orders. Figure 5 shows some of these informations, included in the summary for phase generated by the end of the evaluation sheet of the version.

#	FASE	Qtd Demanda	PF Medido	Horas Vendidas	MMQ					
					R2	(%)	H/PF	MBRE	Chance	E-A
1	DESENV	14	2258	13730	0,34	100%	3,54	4%	50%	5.736,68
2	TOTAL			13730			3,54			5.736,68

Figure 5 – Data for the version´s evaluation and projection of the next version

b) For comparison purposes, the same calculations are also performed (except for the coefficient of determination) for the actual version Delivered Rate (a weighted average of each SO Delivery); the Delivered Rate which represents the median, the first quartile and the third quartile;

c) Aiming to graphically support the evaluation of these different delivery rates, and presenting a dispersion graph relating the scope (x) and the effort (y) of every SO in the version. Figure 6 illustrates this graph, highlighting a SO that ask attention to a more detailed analysis because of its size compared to the others.
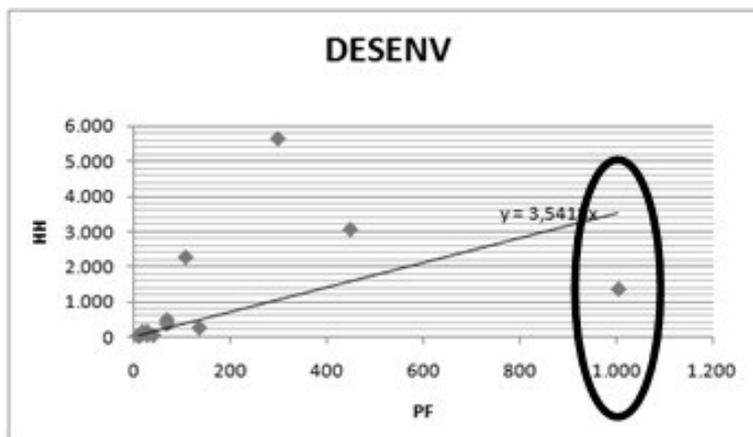

Figure 6 – Relation between FP and Hours-staff per SO

d) Finally, we present a frame showing the minimum, the first quartile, the median, the third quartile, the maximum, the average, the standard deviation of the function points, work hours and delivery rate; Figure 7 illustrates these data. An application of those information is to identify if there was any SO outside the standard curve of productivity. For example, the greatest demand was measured in 1003 function points while 75% of the demands were measured in 127 function points or less. It shows that this demand should be evaluated by itself; considering its particularities in separate from the rest of the version. Those data also support the evaluation of the normality in the distribution of the productivity among the

Service Orders of the version.

	Mínimo	25%	Mediana	75%	Máximo	Média	D.Padrão
PF	7	18,5	53	127	1003	161,29	273,36
Horas	8	24,25	185,5	1131,5	5648	980,71	1.643,49
HH/PF	0,62	1,43	3,52	7,0025	21,32		6,59

Figure 7 - Independent Distribution of FP, Hours-staff and Delivery Rate

This information supports the assessment if the Development Department has achieved its goals as well as defining what will be the goal for the next version.

6- Results Achieved

Visibility. Nowadays, the definition of the scope of the version uses much more objectives inputs. To counterbalance the natural tendency of work to expand, there are forces that imprint a tendency to improve the use of this work. Updated information on the estimated gross productivity (with extra-project hours) and net productivity (just hours directly used on SO) allows the use of corrective measurements in pursuit of productivity goals and decreased consumption of extra-project hours. It is noteworthy that the preexistence of the mechanisms for quality assurance avoids the search for productivity in sacrifice of the product quality.

7- Points to Advance

The focus of this work was originally the four annuals versions of the Suite's products. During its development and aiming to concentrate in the same SO what before was distributed thru a series of enhancements in the same function, the importance of the Service Orders which time frame surpasses the version term increased. A point to advance is systematize the achievements made to the version also for this kind of SO, which became known as "transversion SO".

The main players in the initiative described in this paper were the Planning Department and the Development Department. The same dynamic can (and is intended to) be applied to the Quality Assurance Department aiming its integration to the software production planning and control in order to avoid bottlenecks in the production.

Internally to the Development Department, there exists specialization over the various products of the Suite. All the programming is made by assuming there will be a normal behavior among different version; in every version there is a uniform amount of enhancement to each different product. Improving the model for the SO distribution thru the various products in a more objective manner is another point to advance.

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