ENHANCEMENT IN FUNCTION POINT ANALYSIS

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ABSTRACT

Early and accurate estimation of software size plays an important role in facilitating effort and cost estimation of software systems. One of the commonly used methodologies for software size estimation is Function Point Analysis (FPA). The purpose of software size estimation and effort estimation techniques is to provide a useful measure of the software complexities, efforts, and costs involved in software development. Despite almost three decades of research on software estimation, the research community has yet not able to provide a reliable estimation model for End-User Development (EUD) environments. EUD essentially outsources development effort to the end user. Hence one element of the size and effort is the additional design time expended in end-user programming. This paper discusses the concept end-user programming and enhancement of FPA by adding end-user programming as an additional General System Characteristic (GSC).

KEYWORDS

size estimation, end user programming, function point analysis, end user development

1. INTRODUCTION

End-User Programming system aims to give some programmable system functionality to people who are not professional programmers. One of the most successful computer programs of all times is the spreadsheet applications. The primary reason for its success is that end users can program it without going into the background details of logic and programming. However, end user programming is rare in other applications and where it exists usually requires leaving conventional programming, for example AutoCAD provides LISP for customisation, and Microsoft applications use Visual Basic. More effective mechanism for users is to customize existing applications and create new ones as and when needed.

End-user programming is defined as “Creating a data structure that represents a set of instructions either by explicit coding or by interaction with a device. The instructions are executed by a machine to produce the desired outputs or behaviour” [12].

End-User Programming will be driven by increasing computer literacy and competitive pressures for rapid, flexible, and user driven information processing solutions. These trends will push the software marketplace toward having users develop most information processing applications themselves via application generators. Some example application generators are spreadsheets, extended query systems, and simple, specialized planning or inventory systems [15].

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End-user programmers, who will generally know a good deal about their applications domain and relatively little about computer science in contrast to the infrastructure developers will generally know a good deal about computer science and relatively little about applications [16].

Effort estimation for software projects has proven to be an elusive and expensive problem in software engineering. On one hand, stakeholders expect precise estimates in the early stages of a project; on the other hand, reliably producing those numbers is extremely difficult and may well be technically infeasible. Boehm et al. report that estimating a project in its first stages yields estimates that may be off by as much as a factor of 4. Even at the point when detailed specifications are produced, professional estimates are expected to be wrong by ±50%. [14]

Project estimation involves translating a set of business objectives or requirements into a measure of product “size.” This size measure is then used to estimate the effort, duration, and quality of the final software product. The ability of a system engineer or project manager to align the business objectives with the technical estimates leads to well informed business decisions [19].

2. RELATED WORK

There are many models for software estimation available and prevalent in the industry. Researchers have been working on formal estimation techniques since 1960. Early work in estimation which was typically based on regression analysis or mathematical models of other domains, work during 1970s and 1980s derived models from historical data of various software projects. Among many estimation models expert estimation, COCOMO, Function Point and derivatives of function point like Use Case Point, Object Points are most commonly used [20].

While Lines of Code (LOC) is most commonly used size measure for 3GL programming and estimation of procedural languages, IFPUG FPA originally invented by Allen Albrecht at IBM has been adopted by most in the industry as alternative to LOC for sizing development and enhancement of business applications. FPA provides measure of software functionality based on end user view of application software functionality. Albrecht's view was that it is the function of the system, or what it does that is our primary interest. The number of actual lines of code taken to deliver this function is a secondary consideration. The measure which Albrecht developed is called the Function Point (FP).

The method of sizing software in terms of its function expressed in Function Points is now very widely used. It is interesting to note that FPA came about, not because a new measure of system size was requested, but because productivity was becoming increasingly important; it was out of the need to measure productivity that FPA was conceived.

2.1 Analysis of End User Programming

End user expects advanced interactive applications that are easy to use and easy to learn. As user interface become easier to use they become harder to create. User interface developers need tools which provide a rich support for development of advance user interfaces. U’ML tool is vital for user interface and end user programming. U’ML looks after all the specification of a modern day’s end user design, development and customisation tool [13].

It is foreseeable that the number of active end-user developers will soon exceed the population of professional programmers. As such, there is a growing need to understand the possible risks and benefits associated with EUD activities. Amongst others, relevant criteria include quality (robustness, usability, learnability, etc.), cost, maintainability, and fit-for-purposefulness.
Given the diversity of end-user developers, their activities and conditions, software development frameworks must be flexible enough to respond rapidly to changing contexts and requirements. This is currently infeasible with traditional Software Engineering methodologies. A more attractive solution is to empower end-users to design, integrate and adapt software to meet their changing needs. Despite warnings that EUD may lead to throw-away software [11], end-users will continue to maintain their software whilst they remain motivated to do so. Several research efforts have developed new tools to help end users create effective software. These tools will have significant impact on the software size and hence on the effort required for development.

Over 64 million Americans used computers at work in 1997, and it was estimated that this number will grow to 90 million in 2012, including over 55 million spreadsheet and database users and 13 million self-reported programmers [10]. Existing characterizations of this end user programming becoming common in software usage but it do not provide any guidance on the impact of end user programming on estimating software size and effort.

3. END USER PROGRAMMING CHARACTERISTICS

There are basically only two target users in the real world:

- Developers, who want to see the source code and to write imperative code. These users do not trust model-driven approaches, because they feel this can reduce their freedom in application development;
- Non-developers, who want to ignore all the technical issues and have simple, possibly visual or parameter-based configuration environments for setting up their applications.

There are two general approaches to helping users to design. In one case the computer is an intelligent design assistant that tracks the user’s actions and infers what might be required. This approach is based on programming-by-example (Lieberman, 2001) and extends adaptable user interfaces that automatically change to fit a user profile or react to the user’s behaviour. In the other approach, initiative is left with the user and the system provides powerful tools to support design activity (e.g. Agentsheets: Repenning, 1993). End-user development is a complex field which includes different approaches to helping users instruct machines and design artifacts.

User interfaces of development tools may not be a complex theoretical issue, but acceptance of programming paradigms can be highly influenced by this aspect too. The user interface comprises, for instance, the selection of the right graphical or textual development metaphor so as to provide users with intelligible constructs and instruments. It is worth investigating and abstracting the different kinds of actions and interactions the user can have with a development environment. The end user aspects are prearranged into five phases as in the table 1. In each phase there are interrelated end user programming aspects. These will be the characteristics to be considered whenever the software developers want to estimate for the software size and effort. Hence, end user programming and online help for end user are integrated in existing FPA as GSC.
Table 1
Proposed End User characteristics Formulation

<table>
<thead>
<tr>
<th>Step</th>
<th>End User &amp; Online Help Aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan(P)</td>
<td>End user requirement</td>
</tr>
<tr>
<td>Design(D)</td>
<td>End User features, Functional Features</td>
</tr>
<tr>
<td>Code(C)</td>
<td>Coding of tools, review and audit</td>
</tr>
<tr>
<td>Test(T)</td>
<td>Review &amp; Testing</td>
</tr>
<tr>
<td>Deploy(D)</td>
<td>Software installation &amp; Monitoring</td>
</tr>
</tbody>
</table>

4. REVIEW OF FUNCTION POINT ANALYSIS

Function Point Analysis (FPA) [3][14] consists of two main parts in the measurement. In the first part following functionalities are counted while counting the function points of the system.

- **Data Functionality**
  - Internal Logical Files (ILF)
  - External Interface Files (EIF)

- **Transaction Functionality**
  - External Inputs (EI)
  - External Outputs (EO)
  - External Queries (EQ)

The second part is 14 General System Characteristics (GSCs) that measured from 0 to 5 nominal scales. These characteristics contribute to Value Adjusted Factor (VAF). The final function point count is obtained by multiplying the VAF times the Unadjusted Function Point (UAF). These 14 GSC's are: Data communication, Distributed functions, performance, heavily used configuration, transaction rate, online data entry, End user efficiency, Online Update, complex processing, Reusability, installation ease, multiple sites, facilitate change [17]. The standard equation for estimation is:

\[ FP = UFP \times VAF \]  
\[ (1) \]

Where UFP = Unadjusted Function Point and VAF = Value Adjusted Factor

As mentioned, the total number of UAF is accumulated from five components as in (2). The simplified equation is as follows:

\[ UFP = EI + EO + EQ + ILF + EIF. \]  
\[ (2) \]

The weights are assigned to each component based on transactional and data function types. For VAF, it is calculated from the summation of 14 GSCs as in (3).

\[ VAF = 0.65 + 0.01 \times \sum_{i=1}^{14} C_i \]
Where

\( C_i = \) degree of influence for each General System Characteristic

\( i = \) is from 1 to 14 representing each GSC

\( \Sigma = \) is summation of all 14 GSCs.

Later on function point was enhanced using the security feature as an additional GSC.

\[
VAF = 0.65 + 0.01 \times \sum_{i=1}^{14} C_i + \text{security} \quad [9]
\]

In recent years, several research projects such as Search Computing, ResEval1, and FAST2 spent substantial effort towards empowering end users (sometimes called expert users, to distinguish them from generic, completely unskilled users), with tools and methods for software development therefore it is proposed to consider End-User Programming as individual characteristic in GSC’s in FPA model.

5. END USER PROGRAMMING ENHANCEMENT FOR FPA

The restriction to 15 factors seems unlikely to be satisfactory for all time. Other factors may be suggested now, and others will surely arise in the future. A more open-ended approach seems desirable. A new factor end user programming can also be added to the existing model as end user programming practices if inbuilt in the software in the form of additional tools enhances the features of the software as well as increases the software size.

\[
VAF = 0.65 + 0.01 \times \sum_{i=1}^{14} C_i + \text{security} + \text{end user programming}
\]

i.e.

\[
VAF = 0.65 + 0.01 \times \sum_{i=1}^{16} C_i
\]

Where

\( C_i = \) degree of influence for each General System Characteristic

\( i = \) is from 1 to 16 representing each GSC

\( \Sigma = \) is summation of all 16 GSCs.

For ease of giving degree of influence, following end user characteristics are listed in Table 2. The user can identify the number of characteristics that might take into consideration during development. The number will indicate the score for degree of influence. Table 2 and table 3 will be the additional characteristic sheet for GSC’s in FPA model.
TABLE 2
EUP characteristics

<table>
<thead>
<tr>
<th>S.No</th>
<th>EUP facilities in software</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Programming by example</td>
</tr>
<tr>
<td>2</td>
<td>Creating throw away codes</td>
</tr>
<tr>
<td>3</td>
<td>Creating reusable codes</td>
</tr>
<tr>
<td>4</td>
<td>Sharing reusable code</td>
</tr>
<tr>
<td>5</td>
<td>Easily understandable codes</td>
</tr>
<tr>
<td>6</td>
<td>Security features in codes for more control by end users</td>
</tr>
<tr>
<td>7</td>
<td>Authentication features</td>
</tr>
<tr>
<td>8</td>
<td>Personnel security</td>
</tr>
<tr>
<td>9</td>
<td>Inbuilt feedback about the correctness</td>
</tr>
<tr>
<td>10</td>
<td>Verification</td>
</tr>
<tr>
<td>11</td>
<td>Tools for analyzing by debugging</td>
</tr>
<tr>
<td>12</td>
<td>Error detection tools</td>
</tr>
<tr>
<td>13</td>
<td>Testable codes</td>
</tr>
<tr>
<td>14</td>
<td>Availability of online help</td>
</tr>
<tr>
<td>15</td>
<td>Self - efficacy: High sense of control over the environment</td>
</tr>
<tr>
<td>16</td>
<td>Perceived ease of use: Apart from extrinsic motivation intrinsic motivation (enjoyment) should be present.</td>
</tr>
<tr>
<td>17</td>
<td>Perceived usefulness</td>
</tr>
<tr>
<td>18</td>
<td>Flexible codes</td>
</tr>
<tr>
<td>19</td>
<td>Scalability features</td>
</tr>
<tr>
<td>20</td>
<td>Ease of Maintenance</td>
</tr>
</tbody>
</table>

As in the EUP characteristics table 20 items are basically considered. The suggested score for degree of influence is as below.

TABLE 3: DEGREE OF INFLUENCE FOR END USER PROGRAMMING

<table>
<thead>
<tr>
<th>Score as</th>
<th>Descriptions to determine Degree of influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None of the above</td>
</tr>
<tr>
<td>1</td>
<td>$1 \leq n \leq 4$</td>
</tr>
<tr>
<td>2</td>
<td>$4 &lt; n \leq 8$</td>
</tr>
<tr>
<td>3</td>
<td>$8 &lt; n \leq 12$</td>
</tr>
<tr>
<td>4</td>
<td>$12 &lt; n \leq 16$</td>
</tr>
<tr>
<td>5</td>
<td>$16 &lt; n \leq 20$</td>
</tr>
</tbody>
</table>

Where $n$ is the number of applicable end user programming characteristics.

6. CONCLUSION AND FUTURE RESEARCH

We project that in 2012, over 13 million workers will “do programming” in a self-reporting sense; however, based on spreadsheet and database usage, it seems likely that the number of end user programmers will be much higher. Consequently, end user programming environments will definitely have impact on software size and effort estimation for software projects. Sizing is a key estimating activity. If the sizes of major deliverables can be predicted within 5 to 10 percent, then the accuracy of the overall estimate can be quite good. The proposed enhancement of FPA is not
analysed at this stage. In the future, we will perform additional analysis with software having end user programming, as well as collect and analyse new survey data, in order to better understand the software usage of end users. We anticipate that more precise estimates and characterizations of end user practices will help researchers target further work in developing languages and tools to assist end users in programming tasks.

REFERENCES

[15] Appendix C: COCOMO II Process Maturity led by Dr. Barry Boehm
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